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updated as appropriate

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2344/20

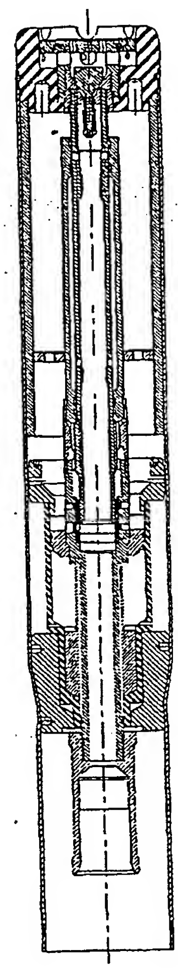

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Fig. 1

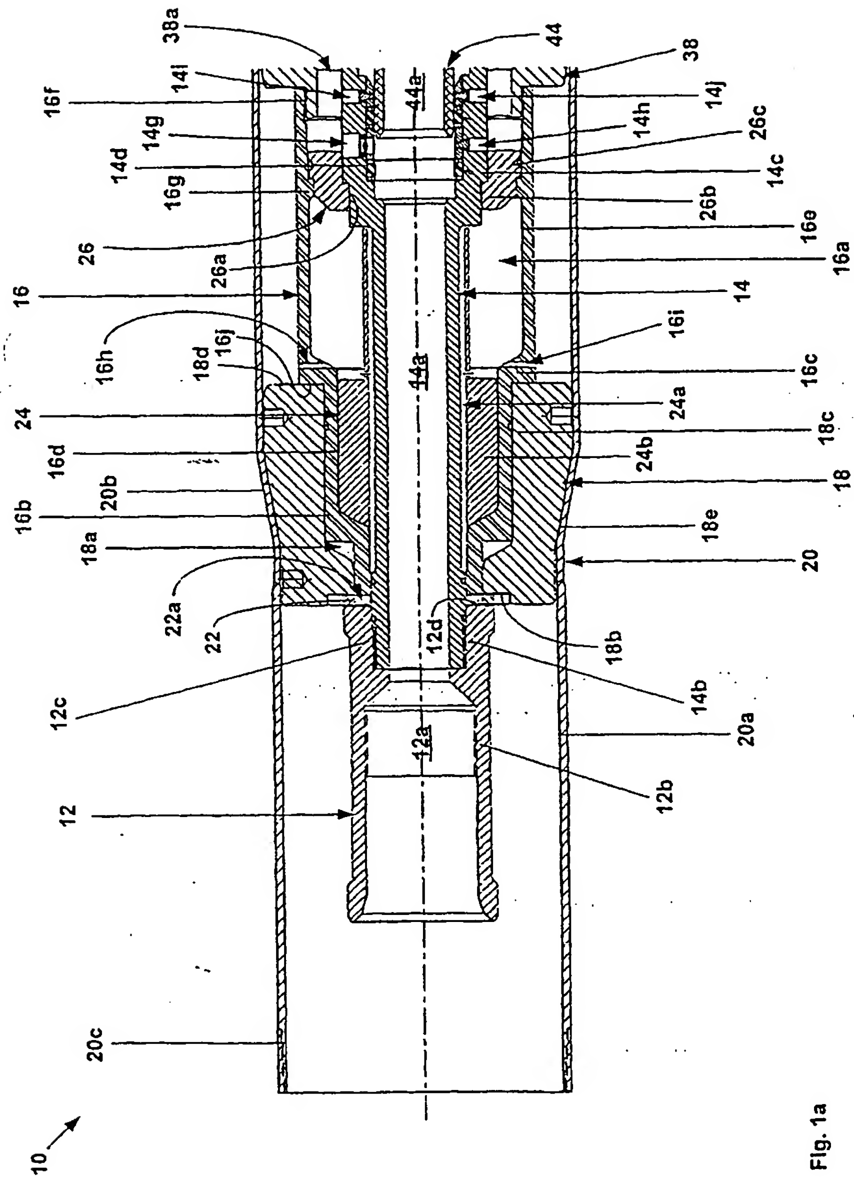
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Fig. 1a

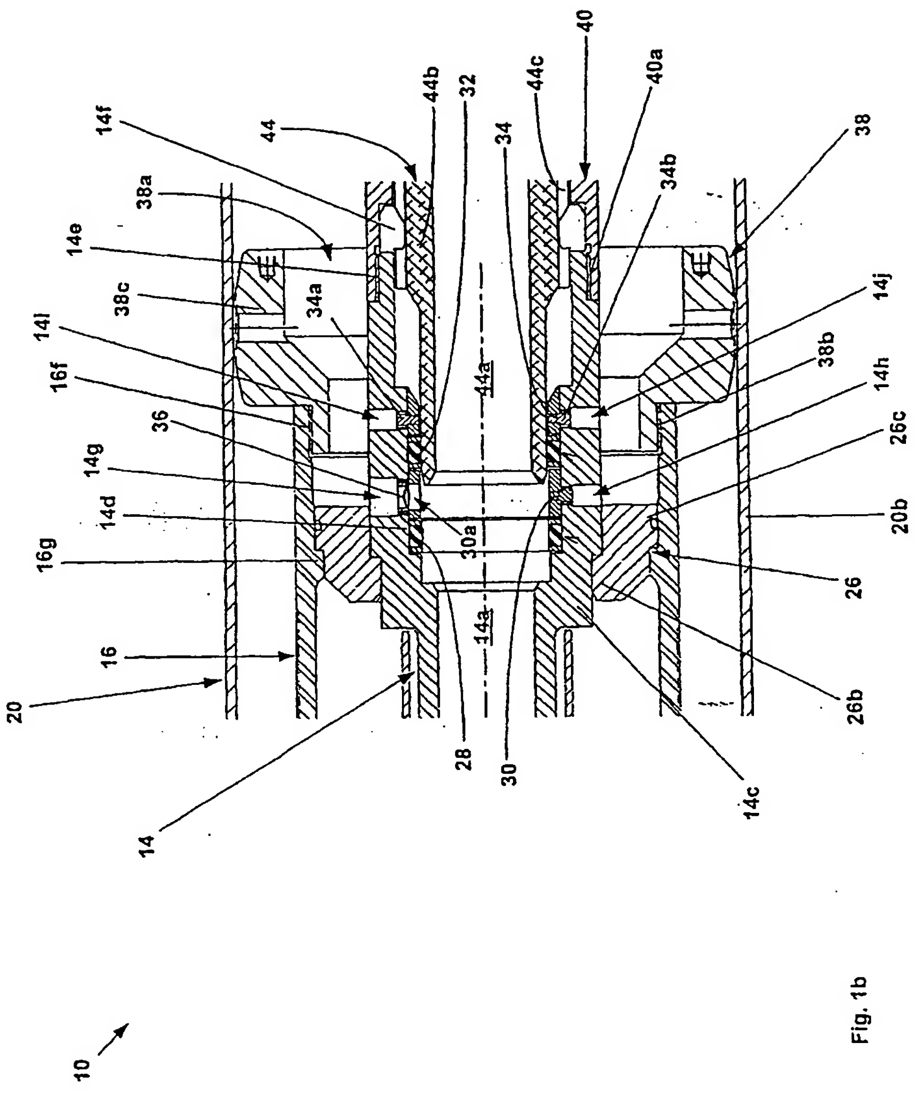

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Fig. 1b

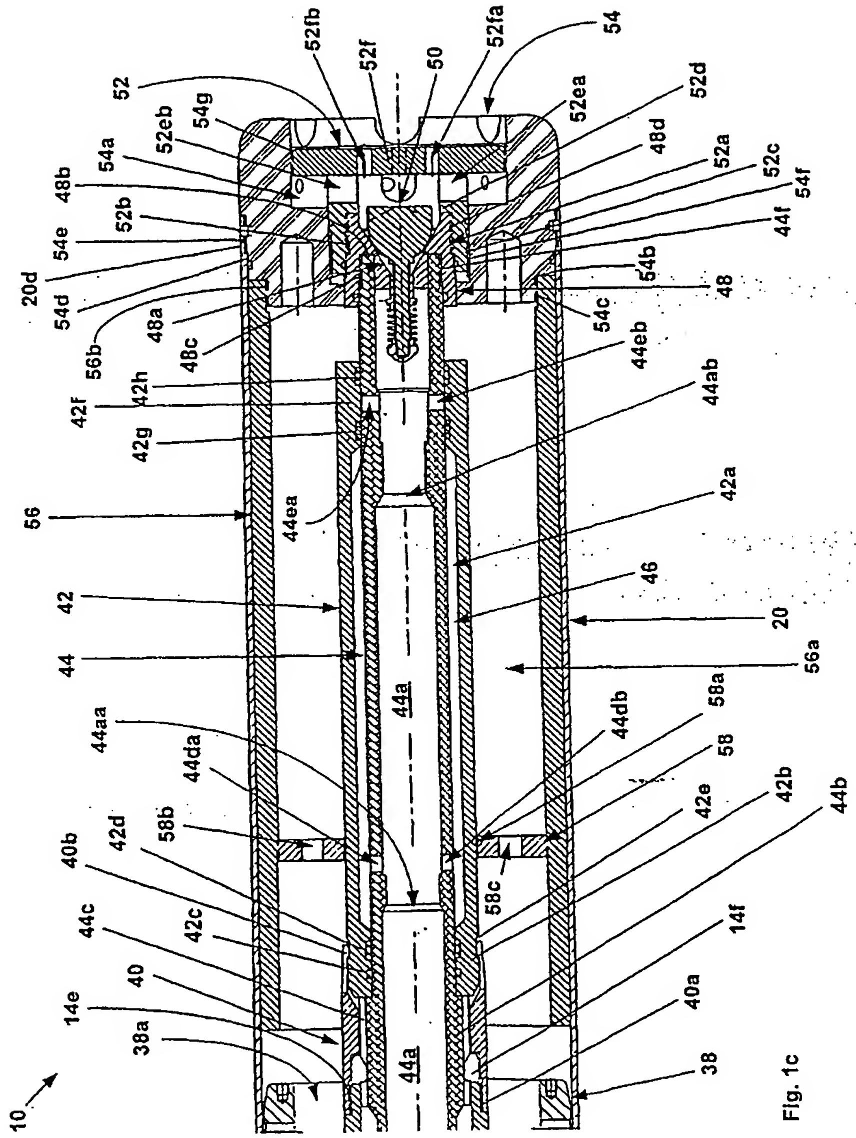
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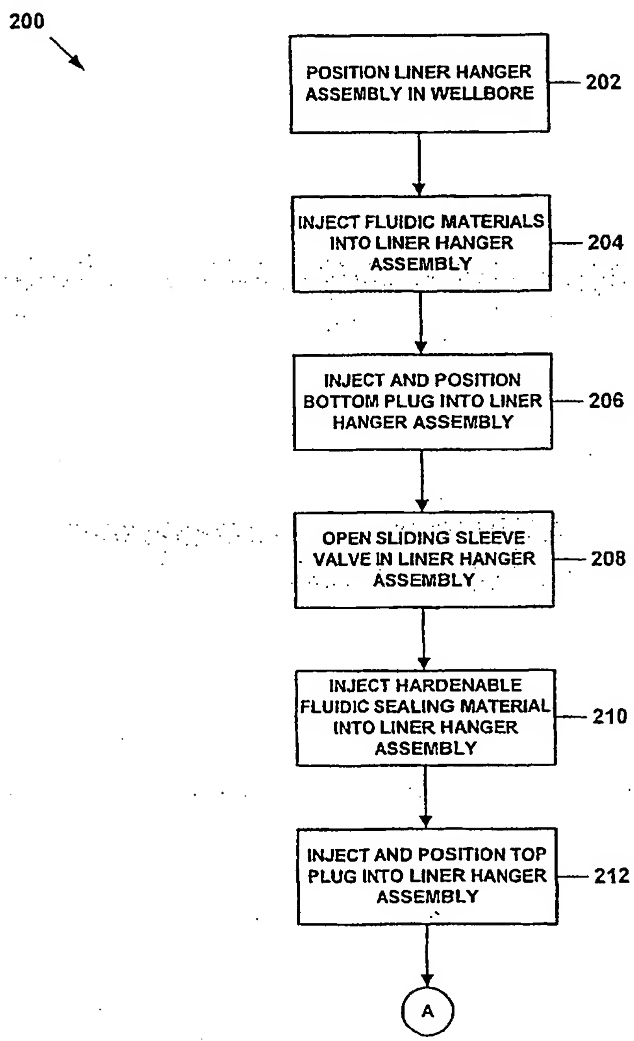
Fig. 1c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INJECT FLUIDIC MATERIALS INTO LINER HANGER ASSEMBLY
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INJECT AND POSITION BOTTOM PLUG INTO LINER HANGER ASSEMBLY
206
OPEN SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
208
INJECT HARDENABLE FLUIDIC SEALING MATERIAL INTO LINER HANGER ASSEMBLY
210
INJECT AND POSITION TOP PLUG INTO LINER HANGER ASSEMBLY
212
A

Fig. 2a

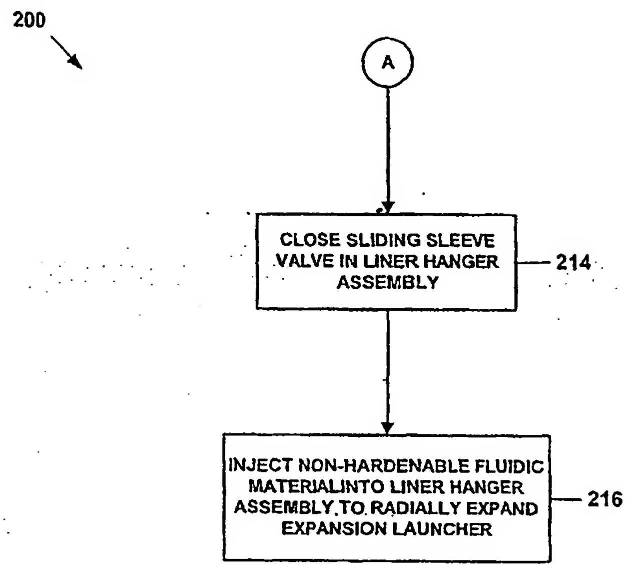
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Fig. 2b

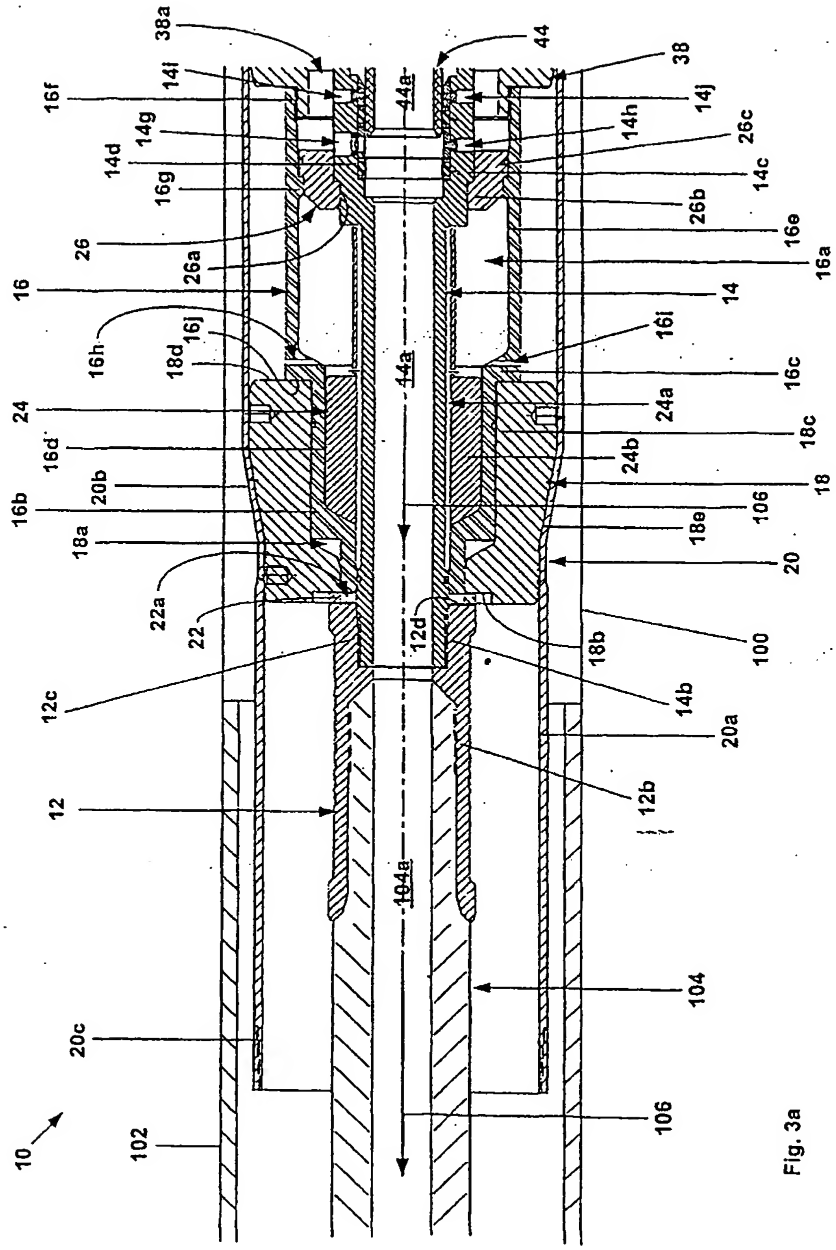
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Fig. 3a

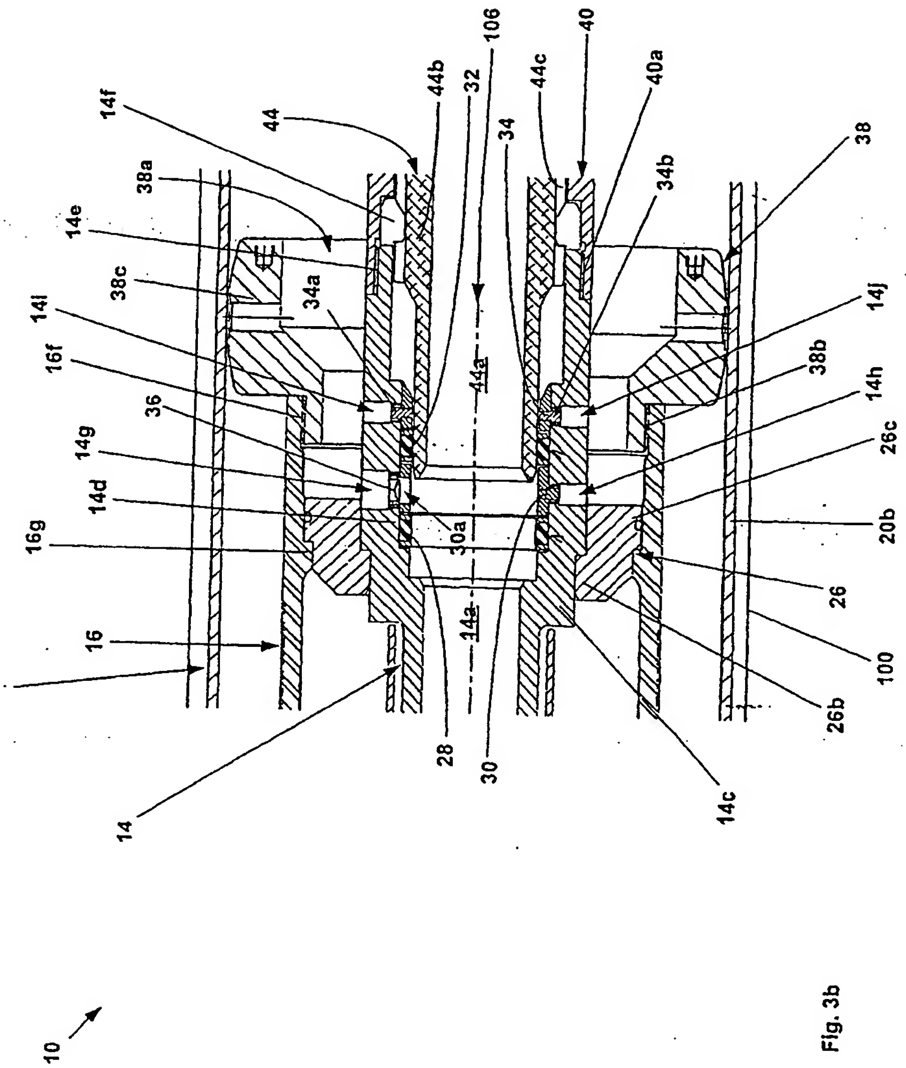
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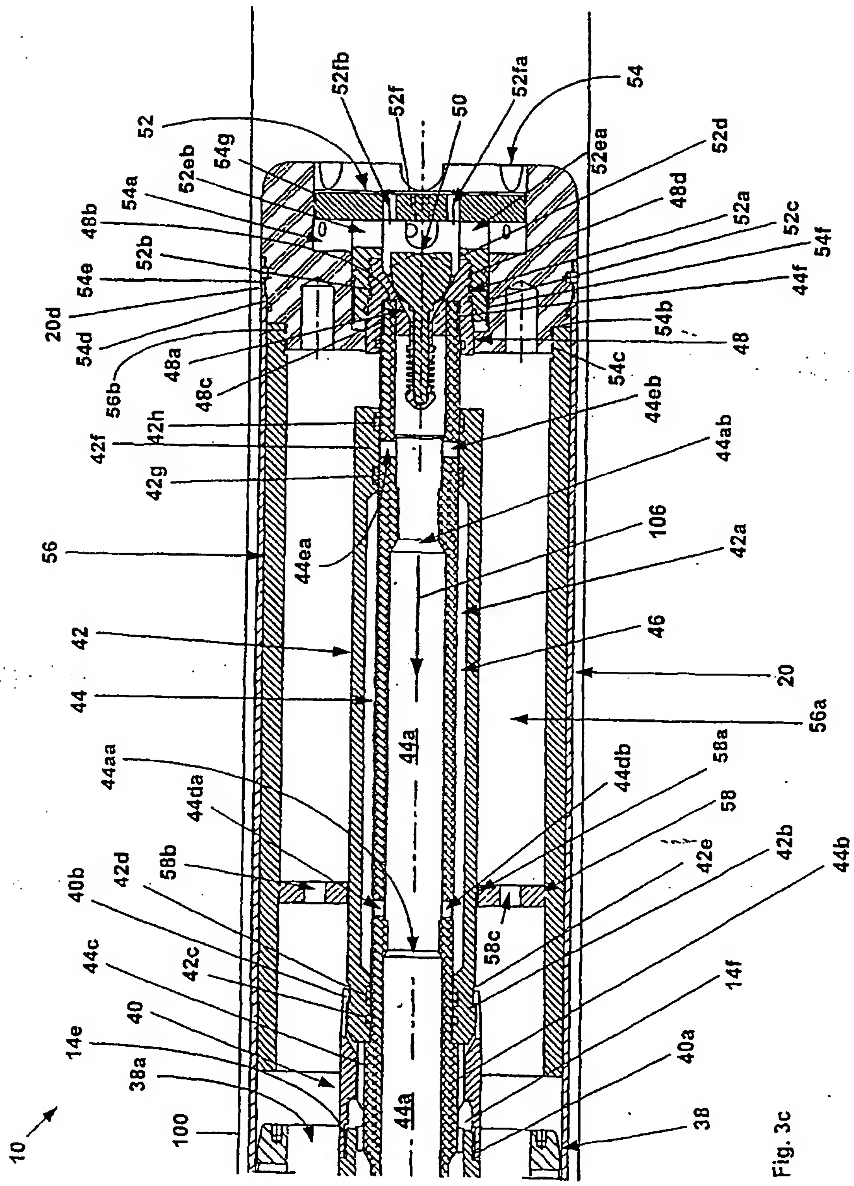
Fig. 3b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52eb
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44eb
44ab
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Fig. 3c

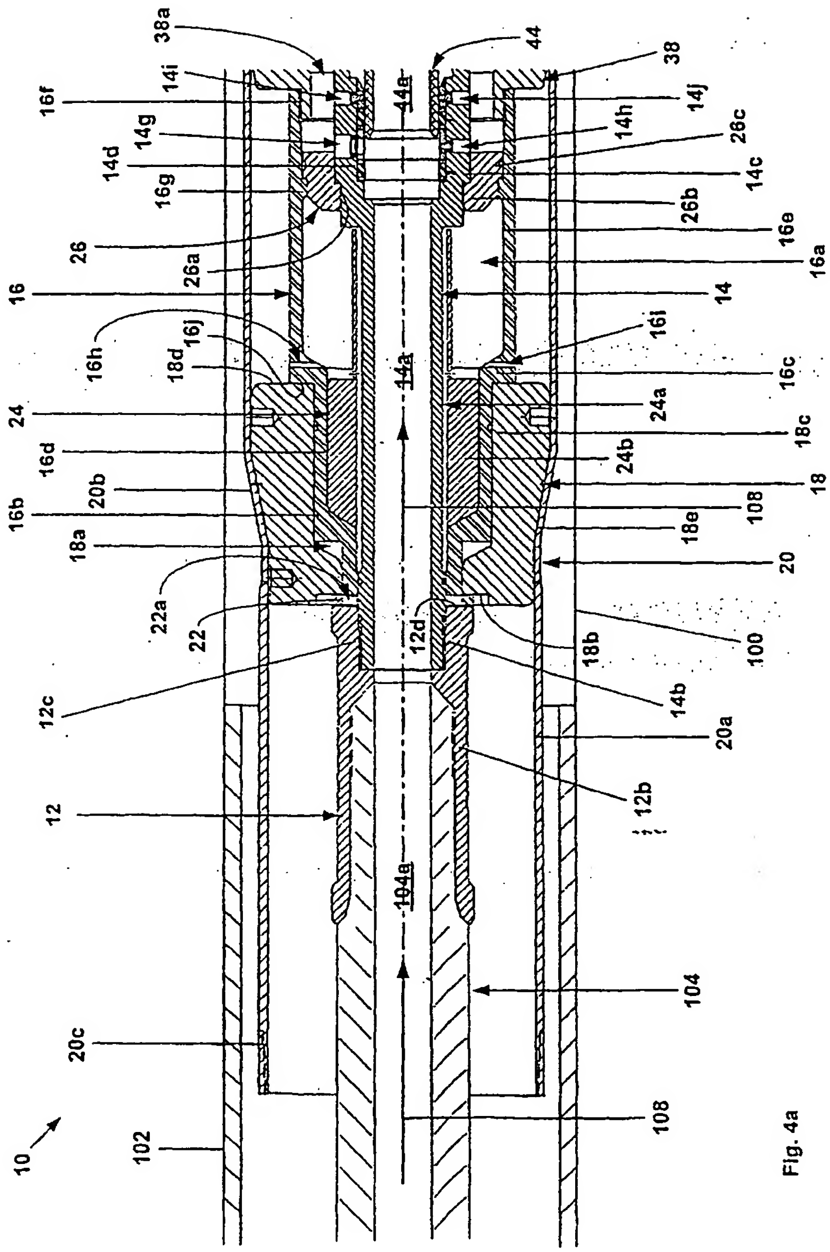

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Fig. 4a

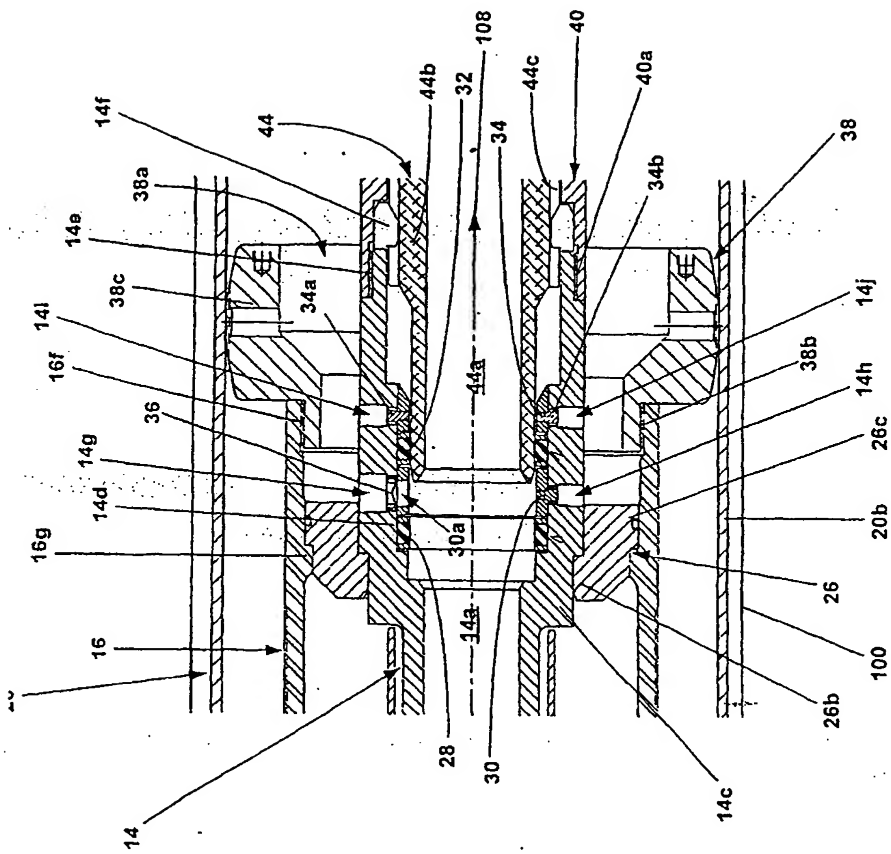
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Fig. 4b

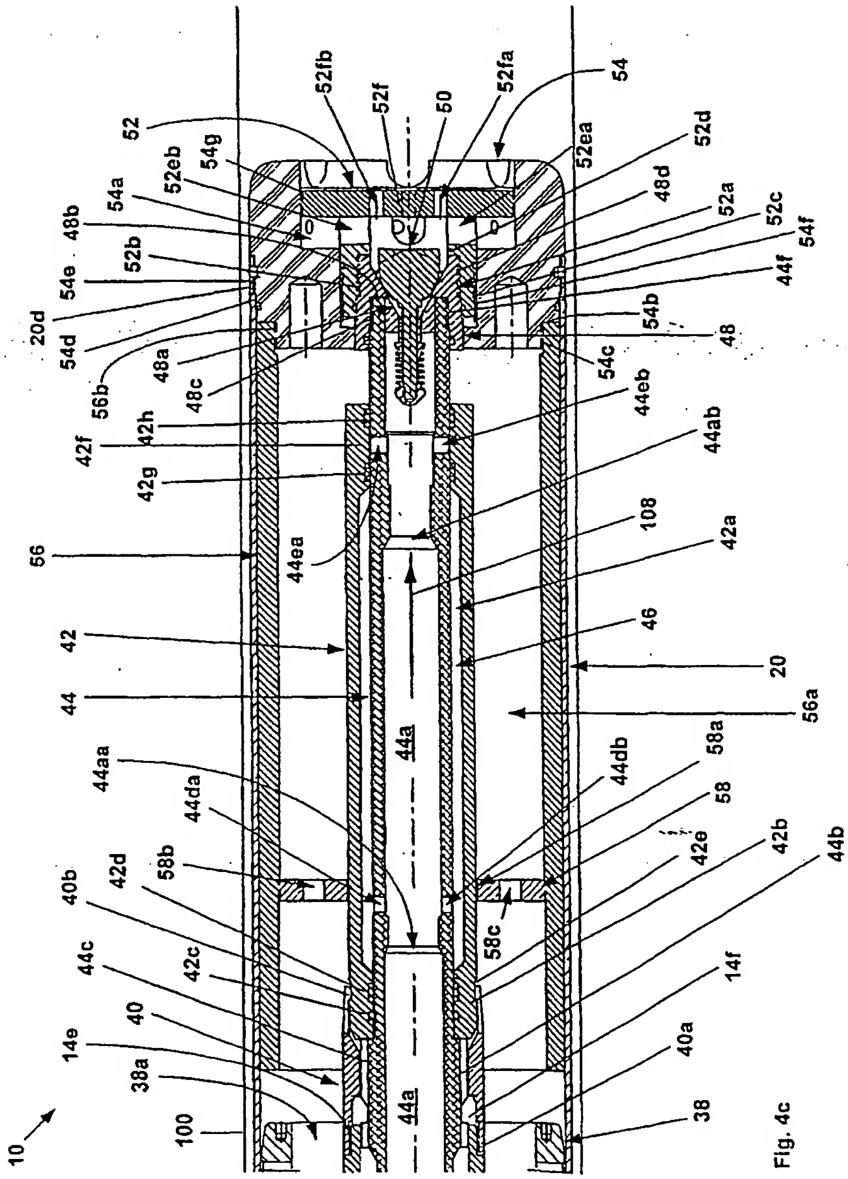
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Fig. 4c

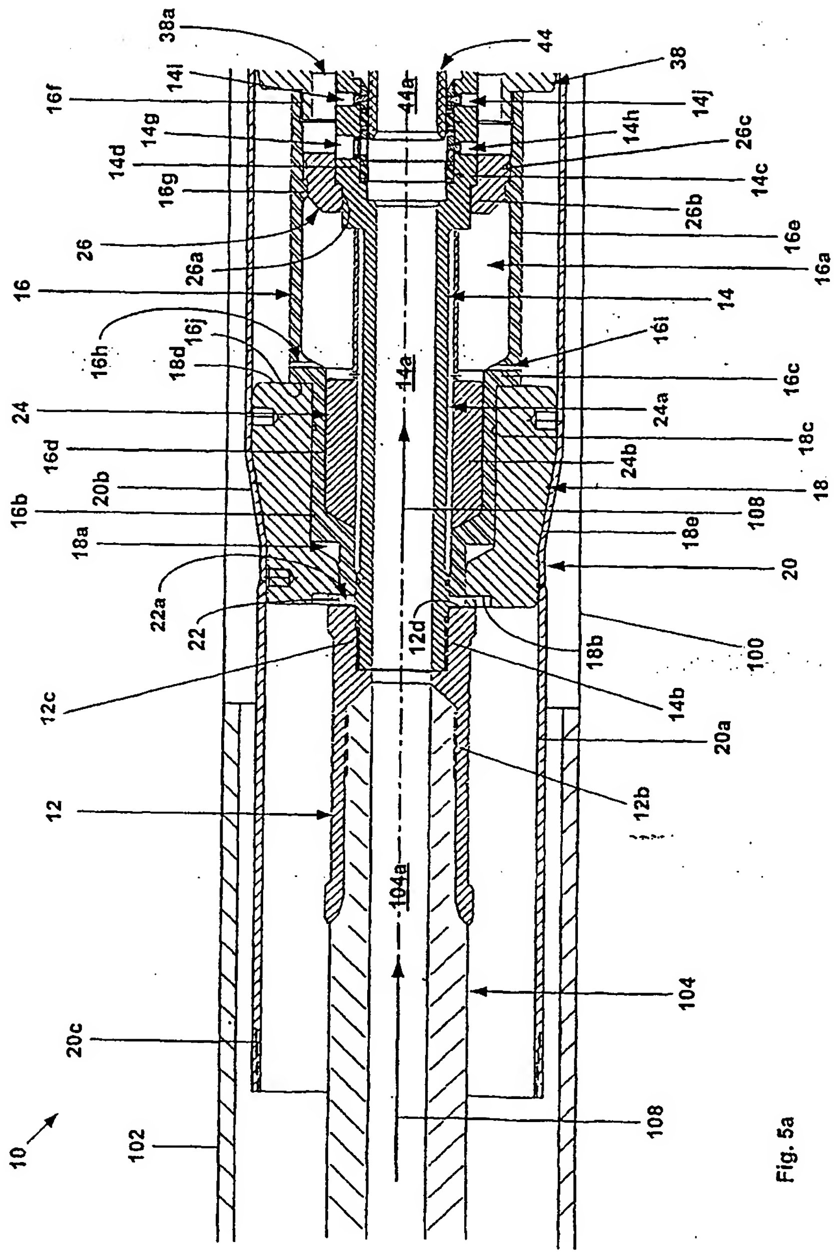
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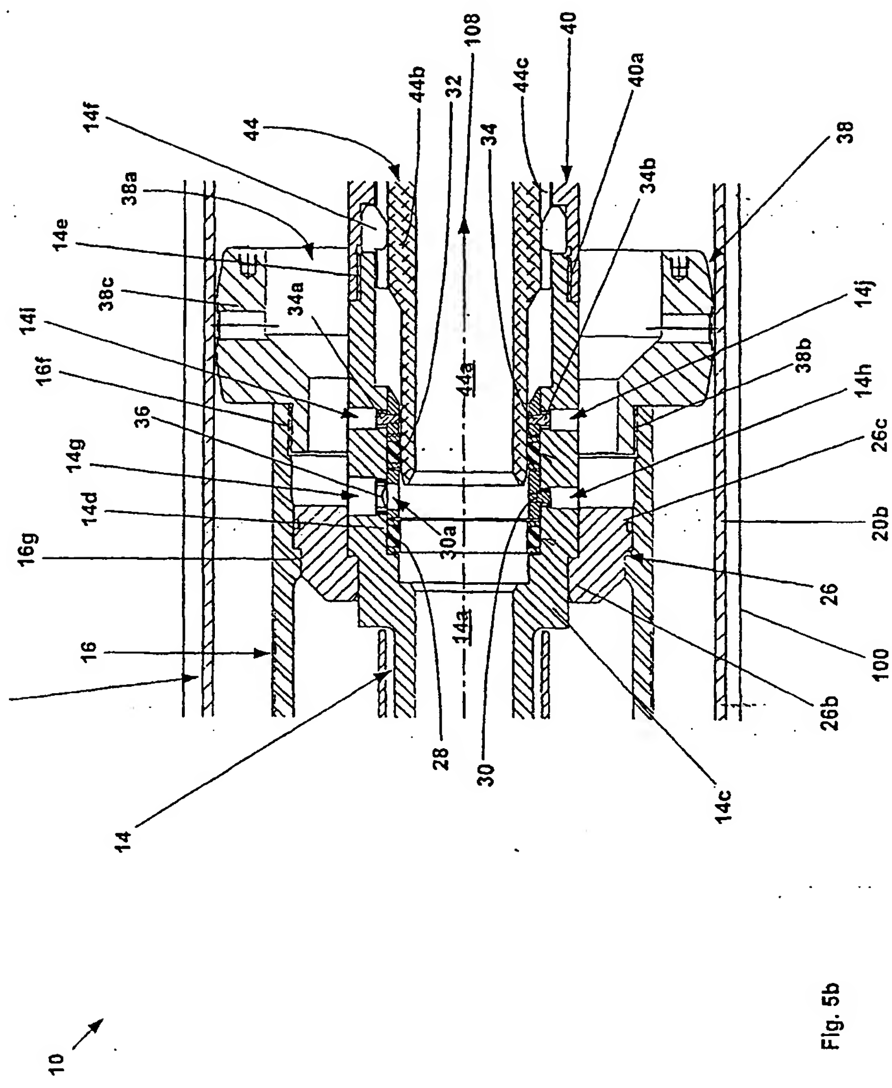
Fig. 5a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14c

Fig. 5b

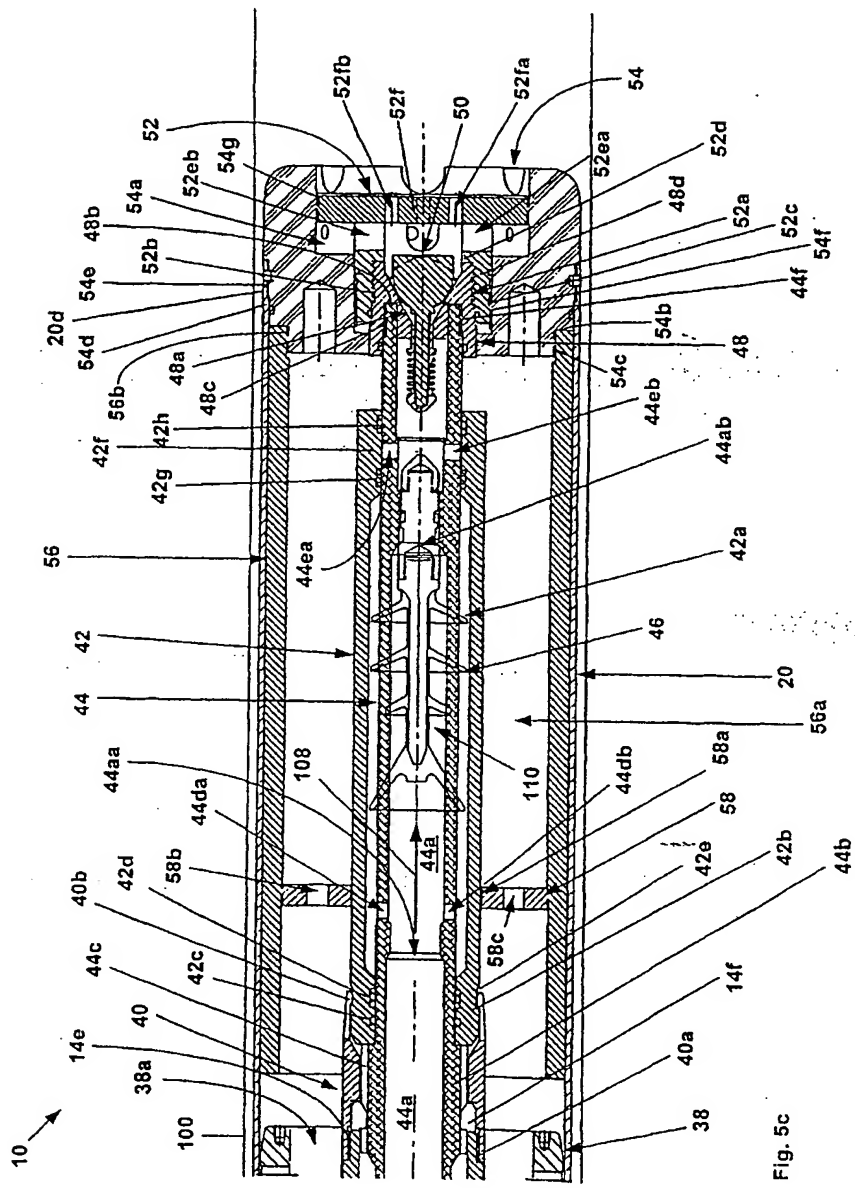
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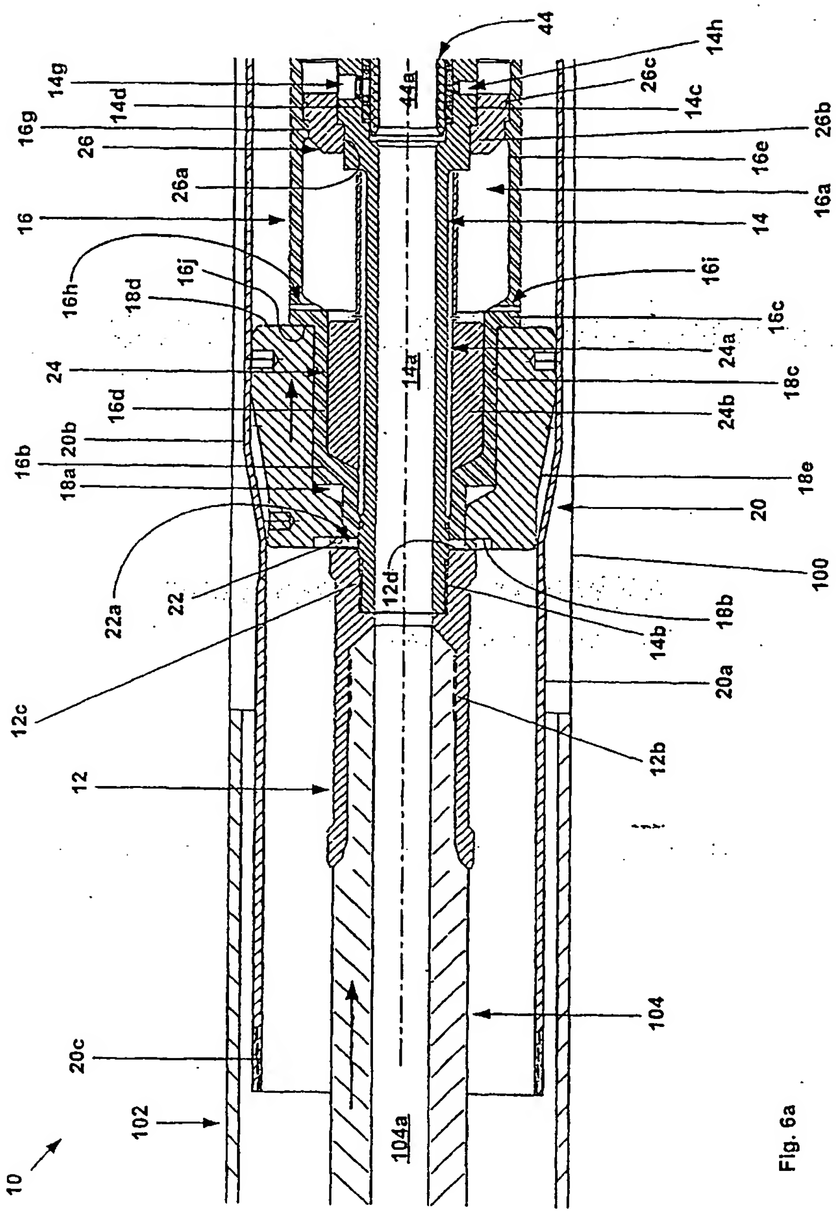
Fig. 5c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18e
18a
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Fig. 6a

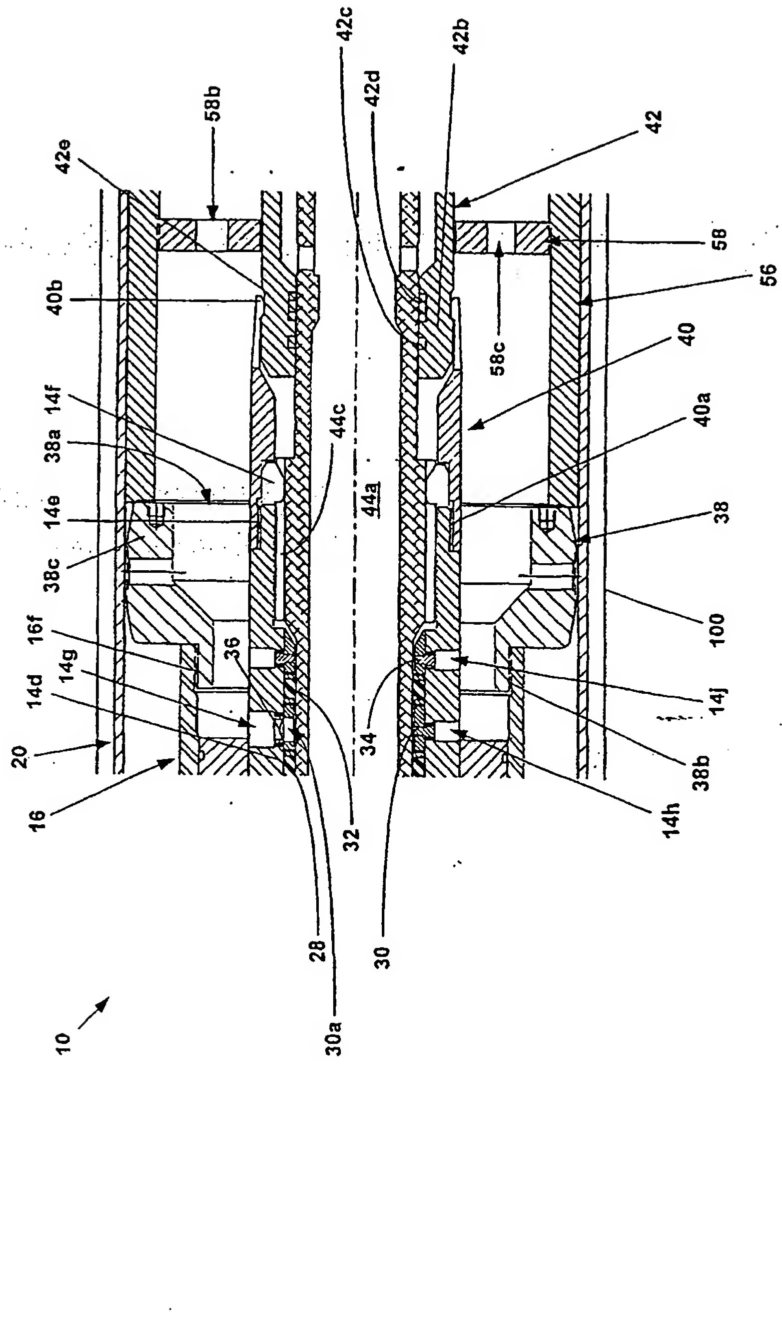

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Fig. 6b

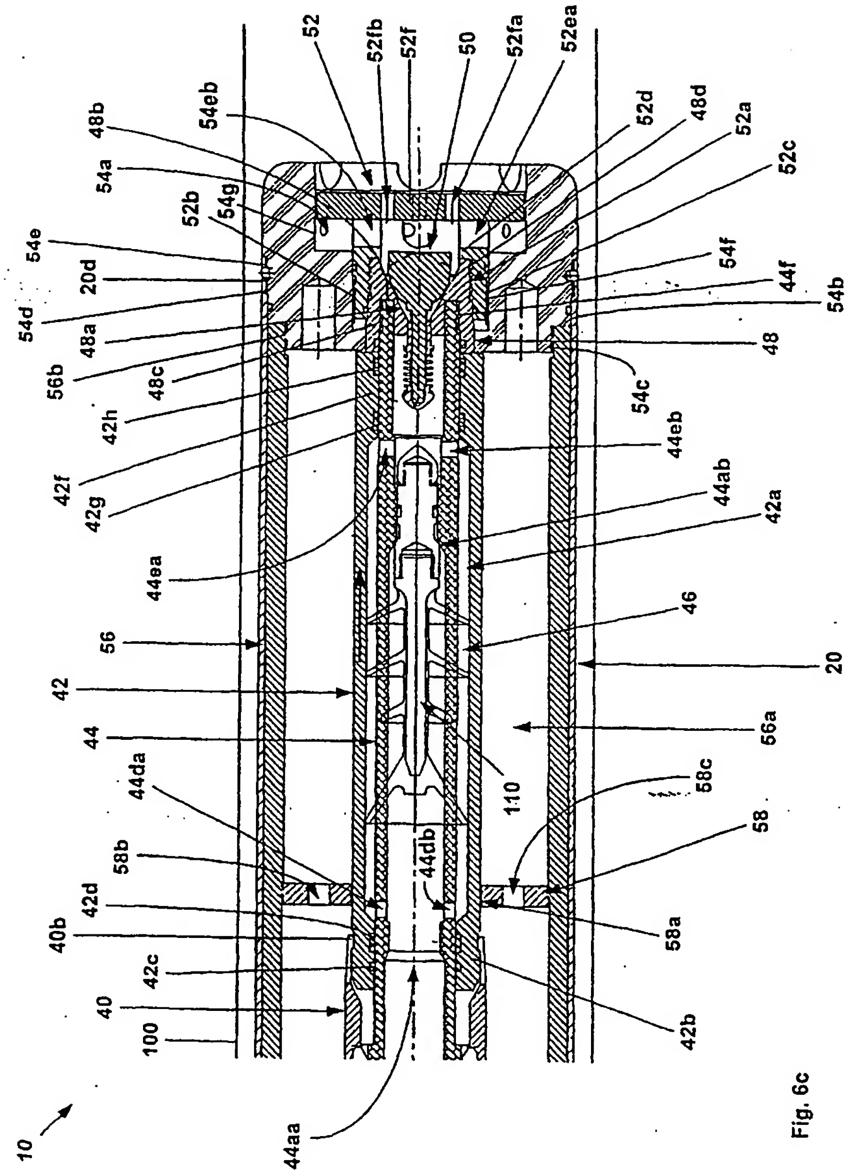
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Fig. 6c

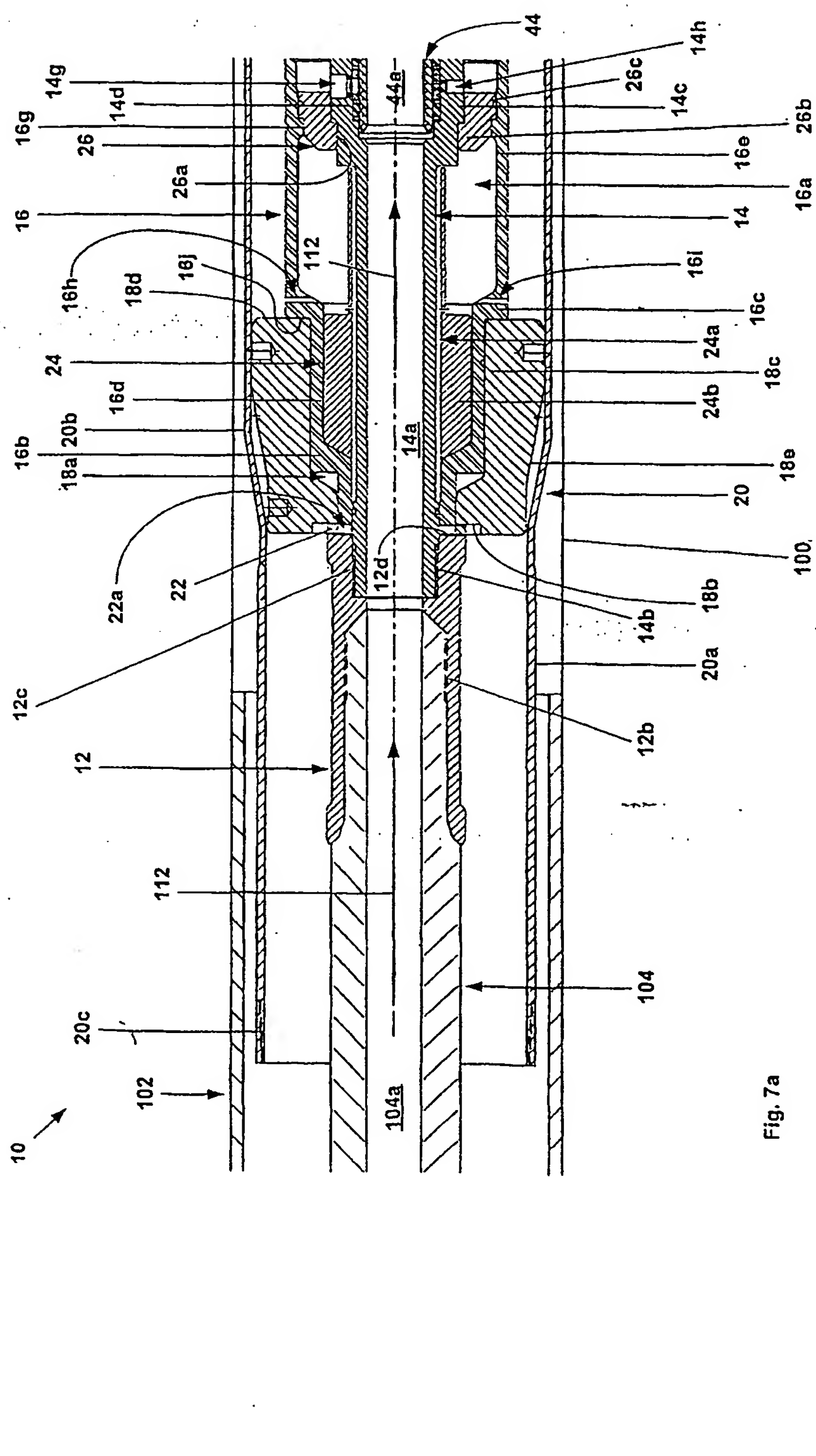
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Fig. 7a

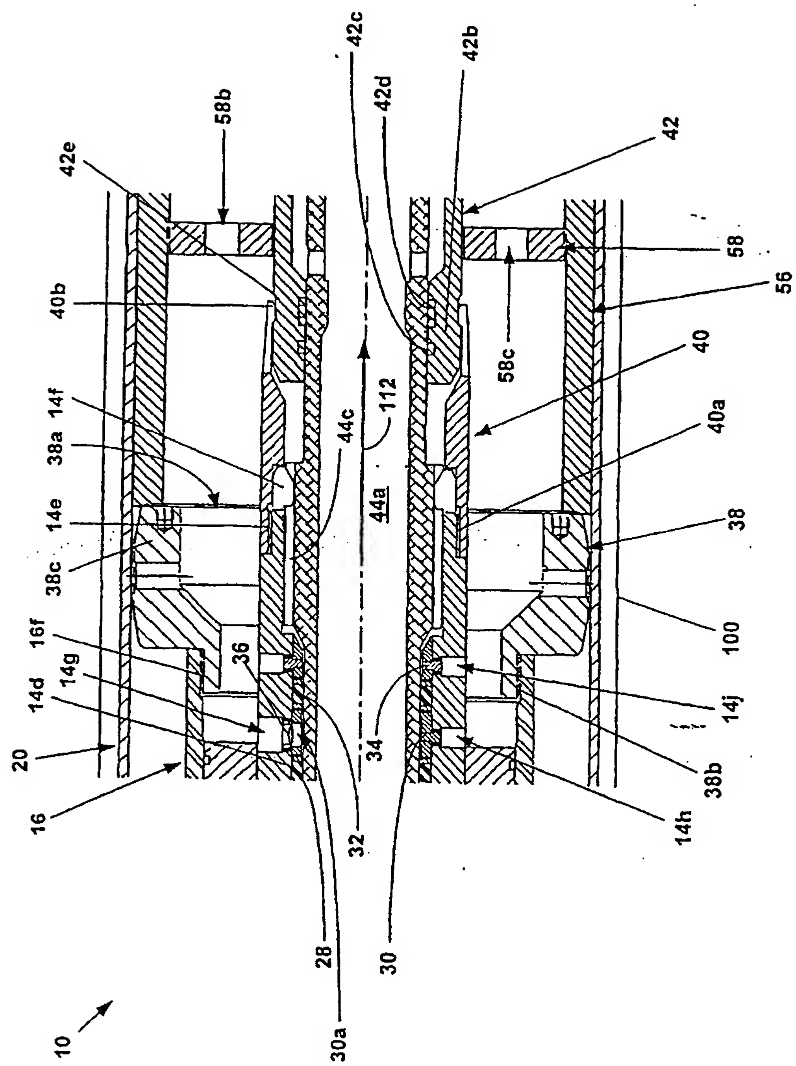
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Fig. 7b

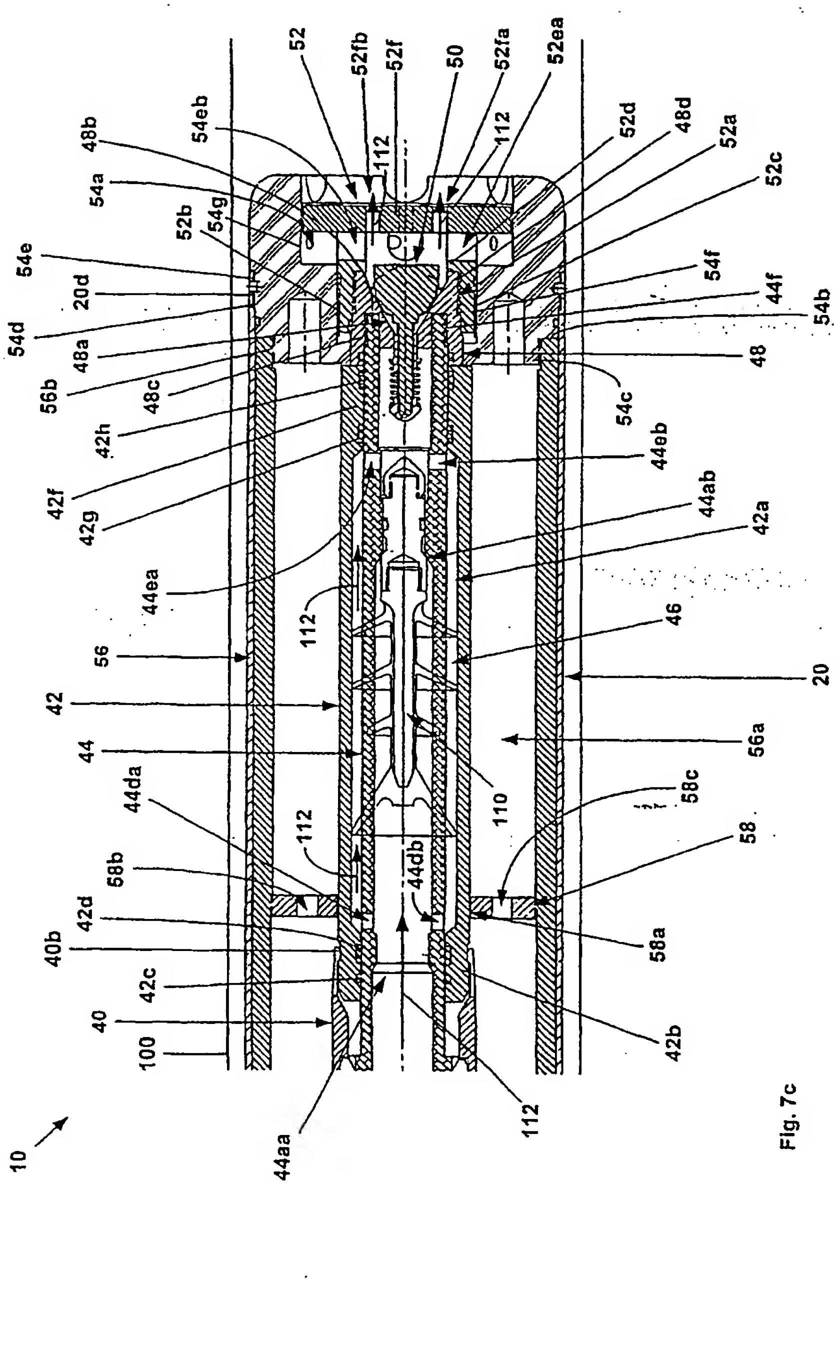
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Fig. 7c

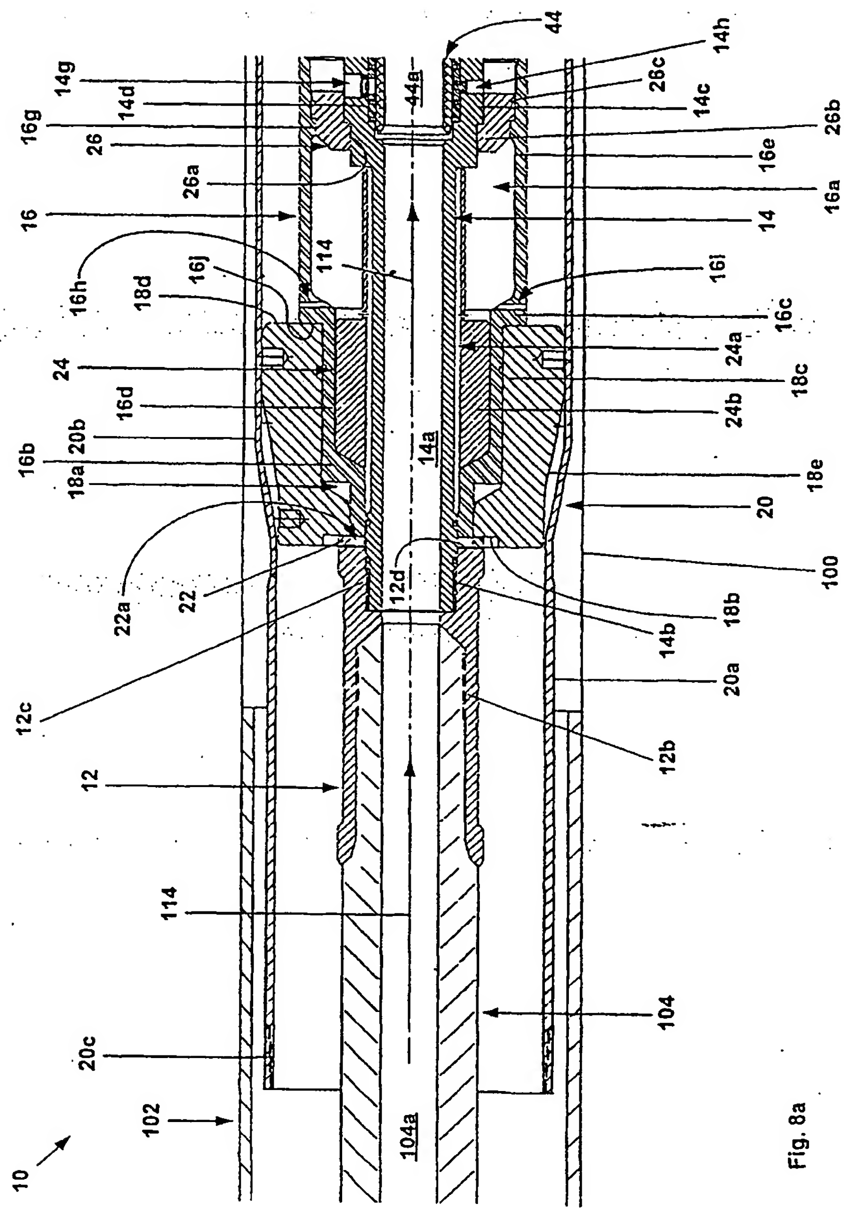

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Fig. 8a

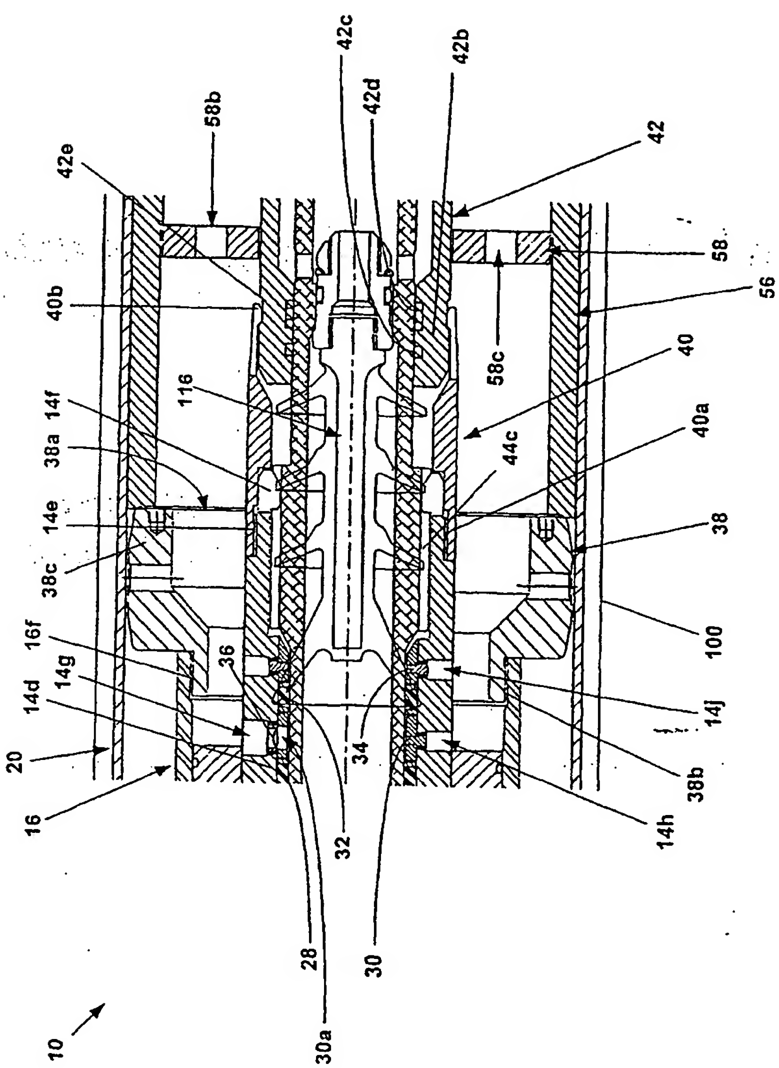
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Fig. 8b

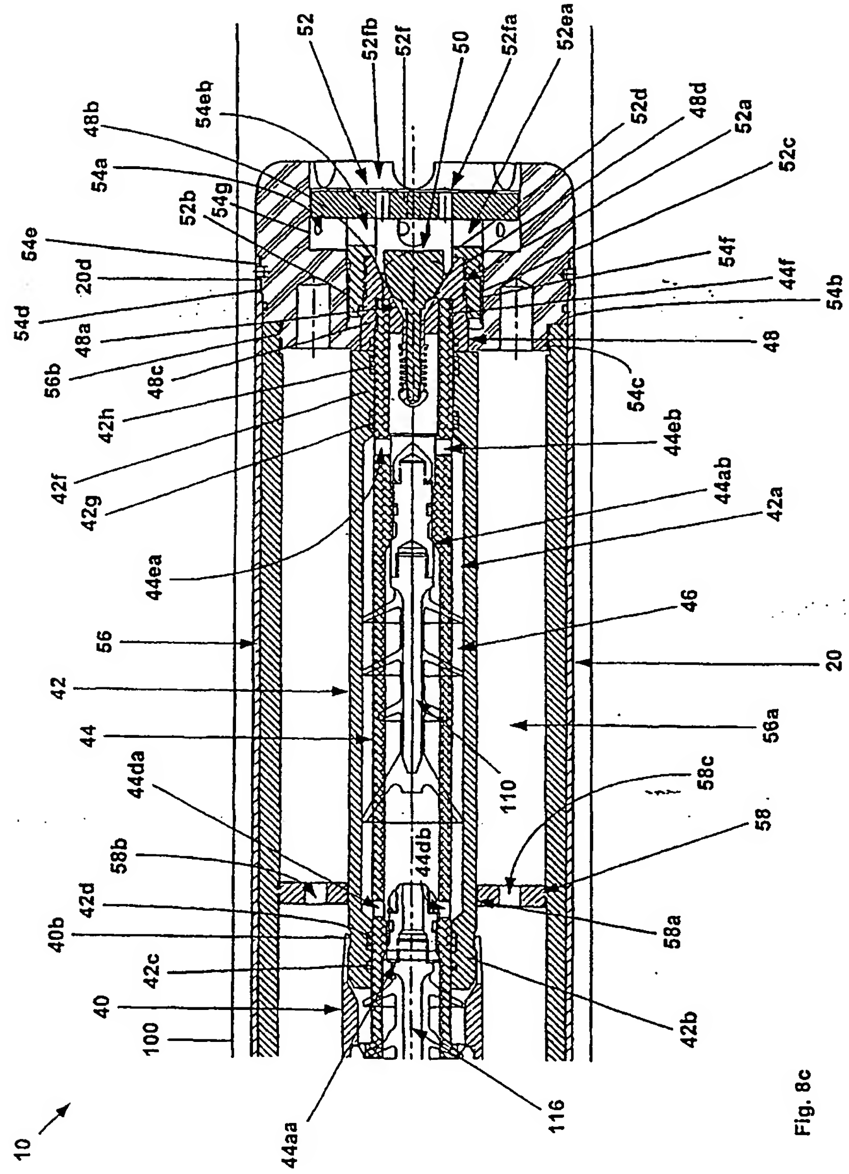
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Fig. 8c

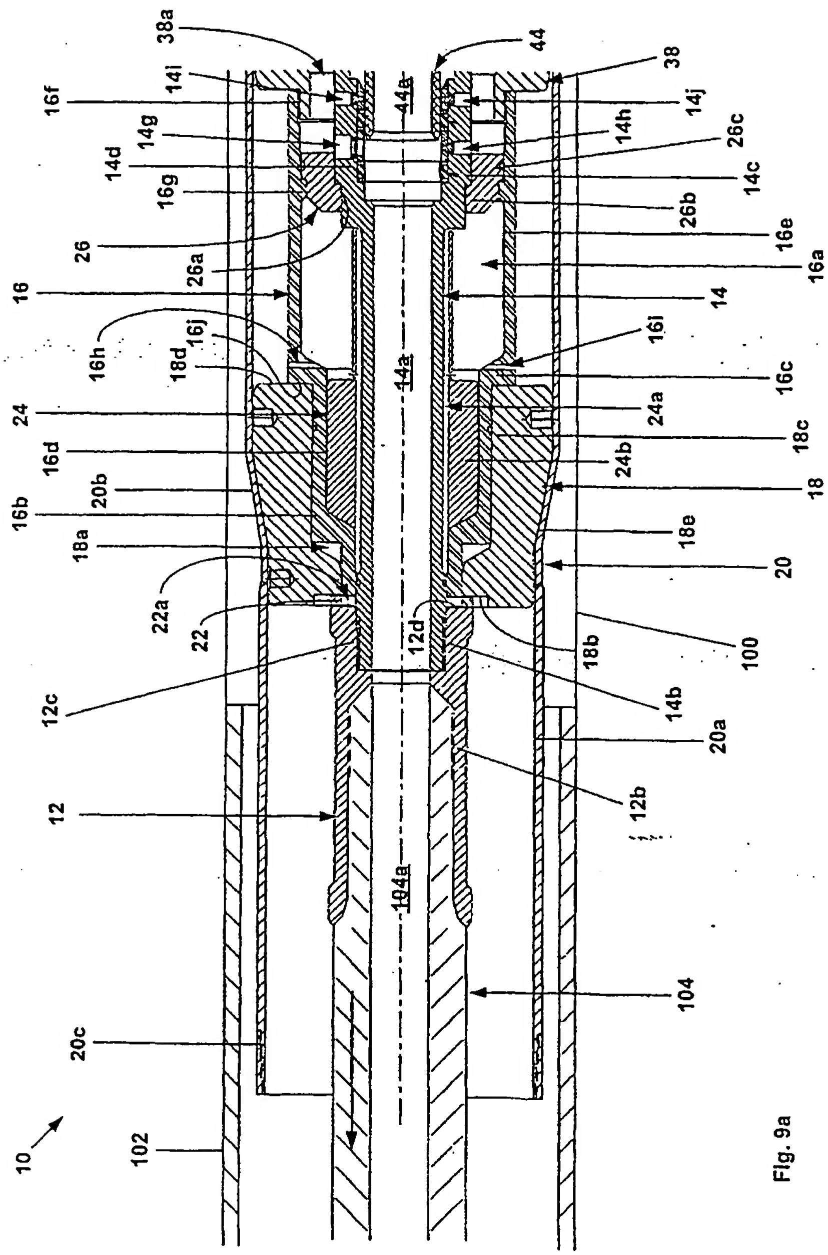
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Fig. 9a

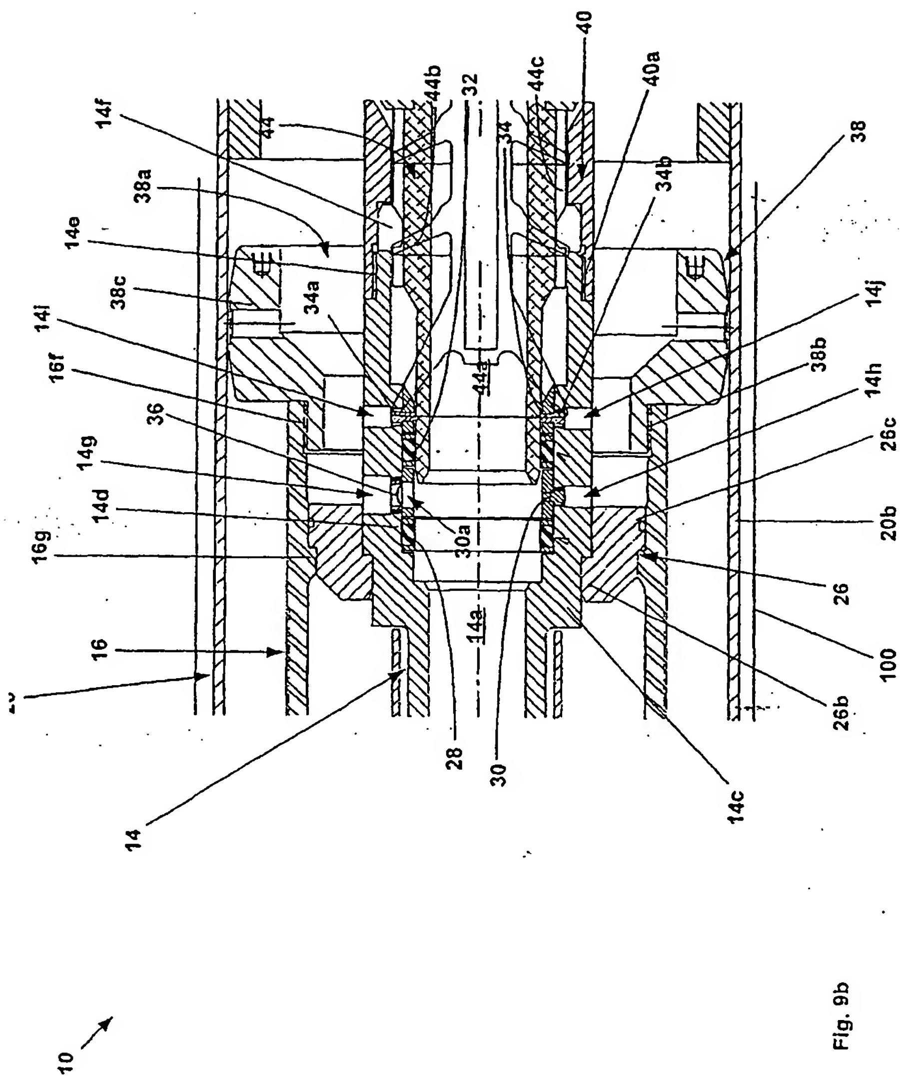
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Fig. 9b

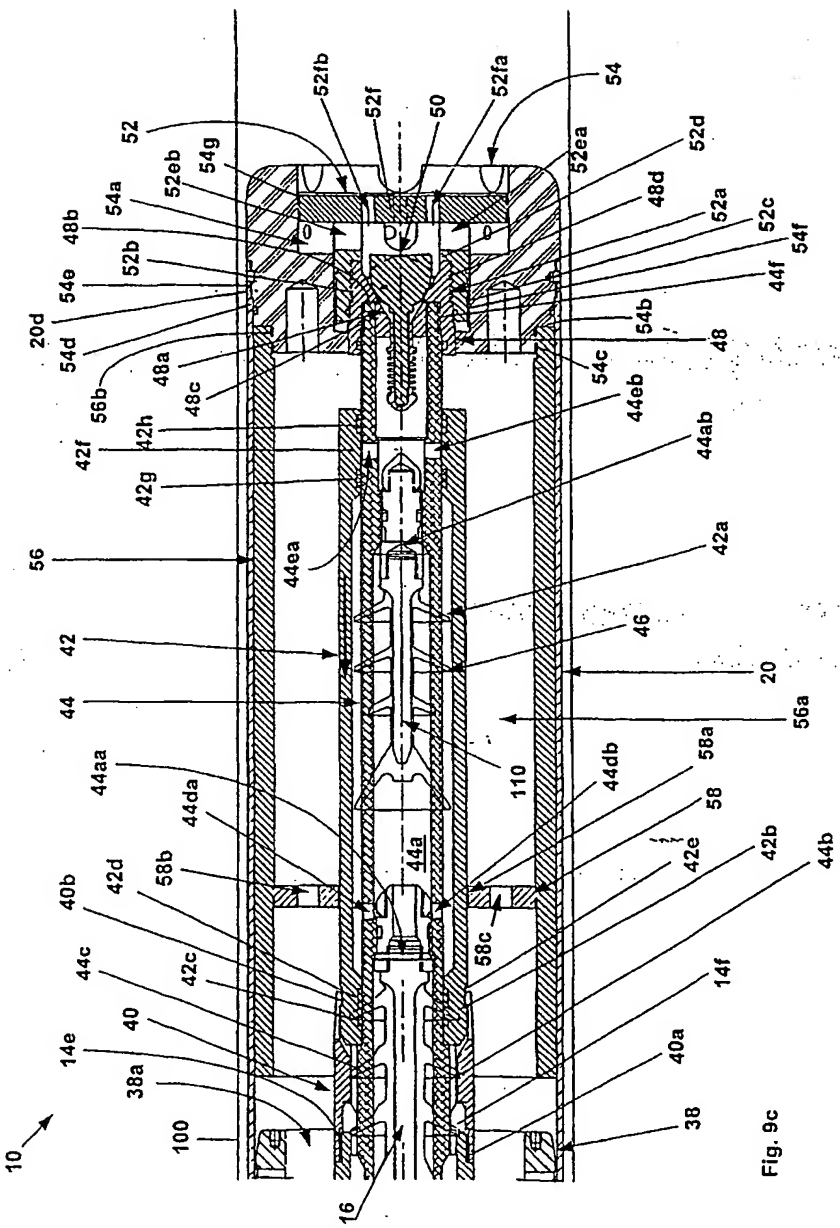
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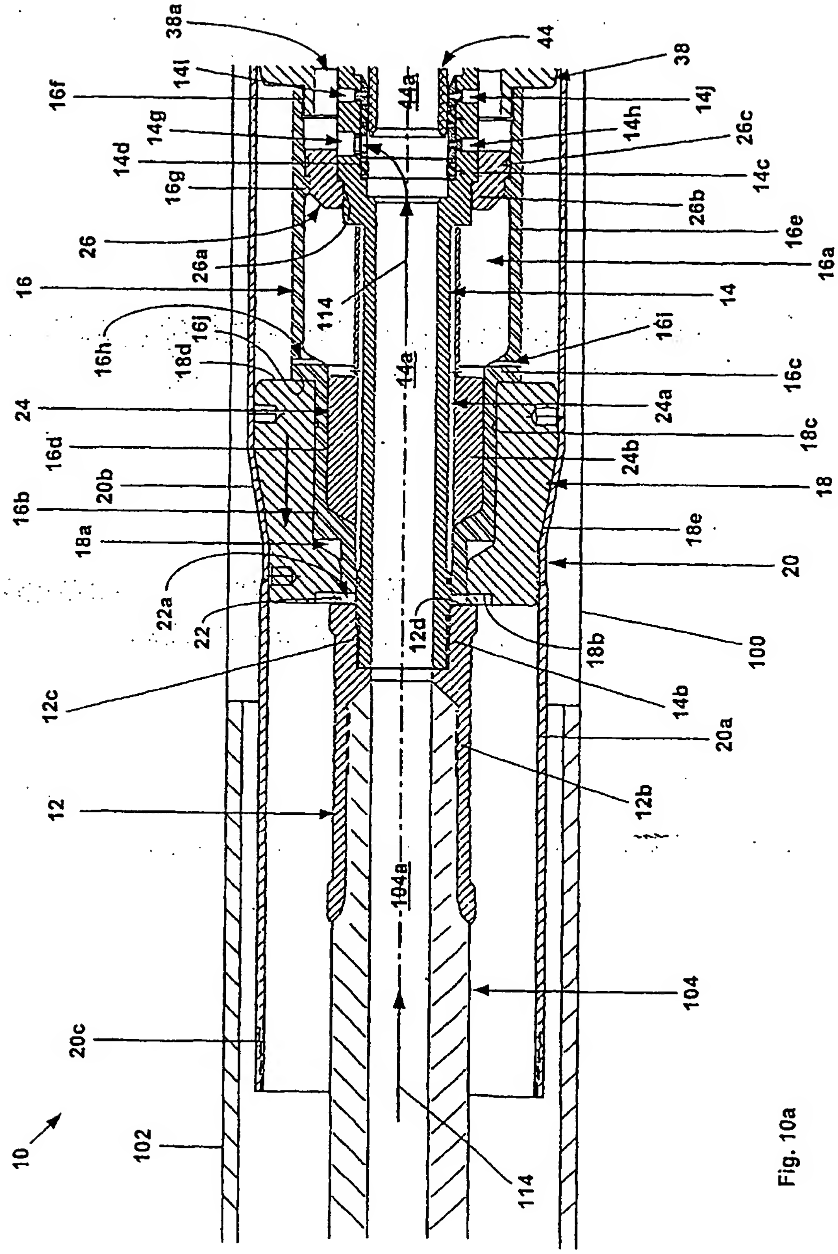
Fig. 9c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44a
14j
16f
14g
14h
14d
26c
16g
14c
26b
26
16e
26a
16a
16
114
14
16h
16j
16i
18d
44a
16c
24
24a
16d
18c
24b
20b
18
16b
18e
18a
20
22a
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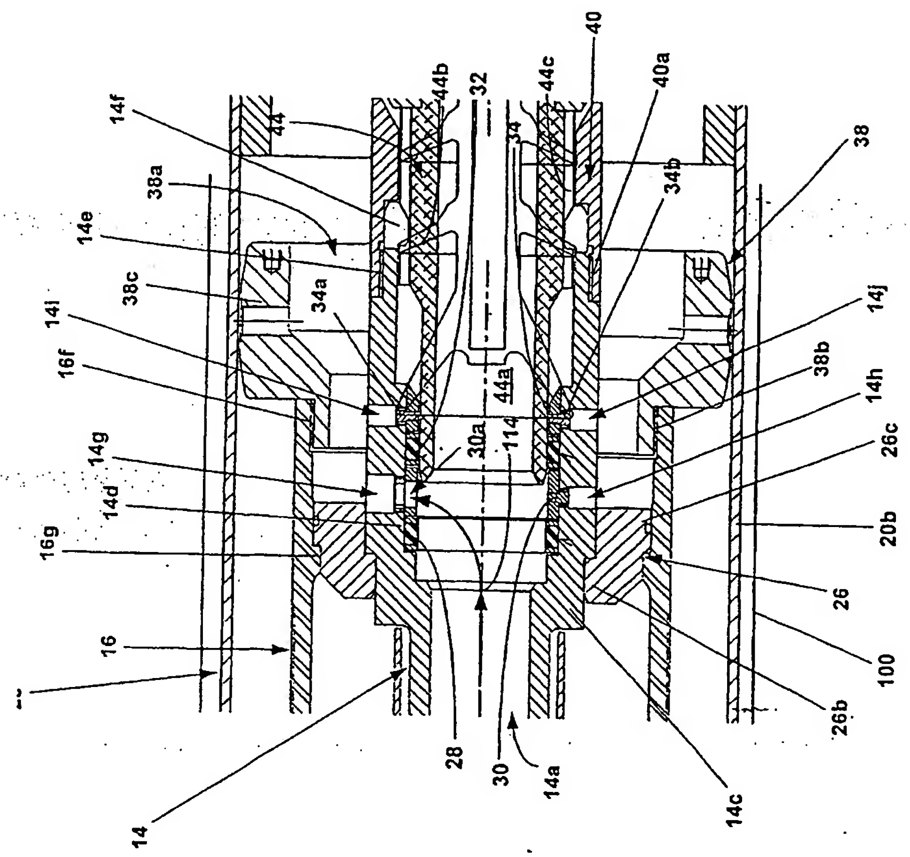
12d
18b
100
12c
14b
20a
12
12b
104a
104
20c
10
102
114

Fig. 10a



14f
44
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44c
40
40a
38a
14e
34
34b
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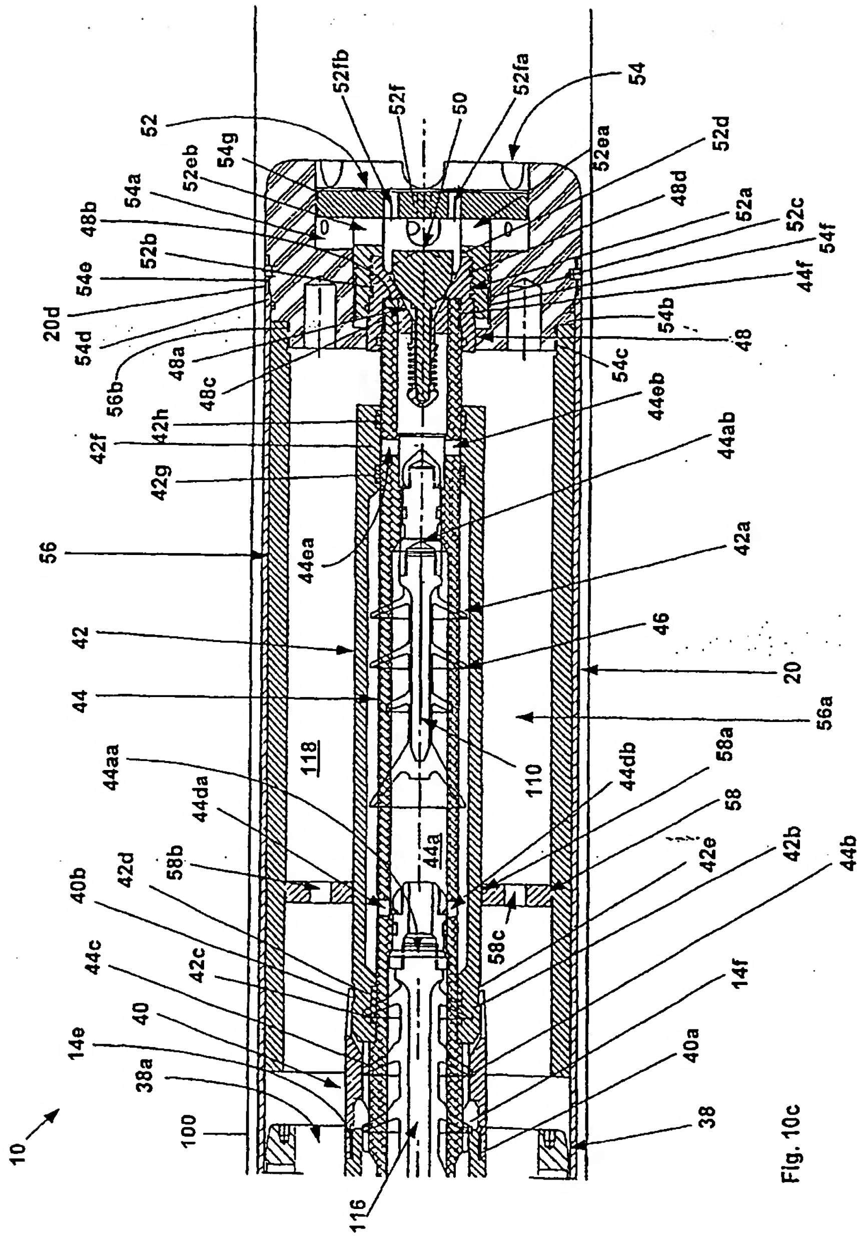
38c
34a
14i
16f
14j
38b
14g
14h
26c
14d
30a
44a
114
16g
20b
26
16
100
26b
28
30
14a
14c
14
10

Fig. 10b



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44c
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42d
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44
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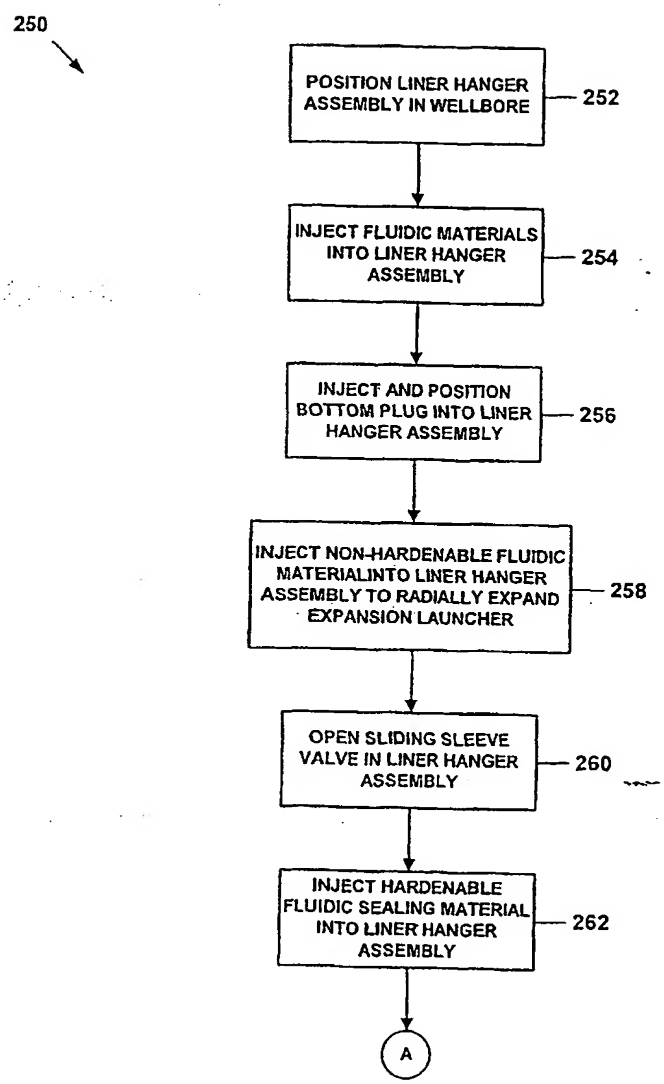
44ea
42g
42f
42h
56b
48c
48a
54d
20d
54e
52b
48b
54a
52eb
54g
52
52fb
52f
50
52fa
54
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
42a
46
20
56a
110
44a
44db
58a
58
58c
42e
42b
44b
14f
40a
38
116

Fig. 10c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POSITION LINER HANGER ASSEMBLY IN WELLBORE
252
INJECT FLUIDIC MATERIALS INTO LINER HANGER ASSEMBLY
254
INJECT AND POSITION BOTTOM PLUG INTO LINER HANGER ASSEMBLY
256
INJECT NON-HARDENABLE FLUIDIC MATERIALINTO LINER HANGER ASSEMBLY TO RADIALLY EXPAND EXPANSION LAUNCHER
258
OPEN SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
260
INJECT HARDENABLE FLUIDIC SEALING MATERIAL INTO LINER HANGER ASSEMBLY
262
A

Fig. 11a

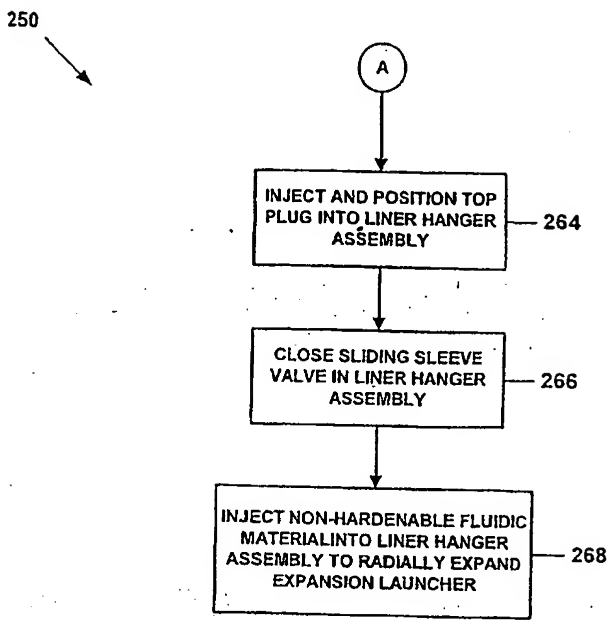
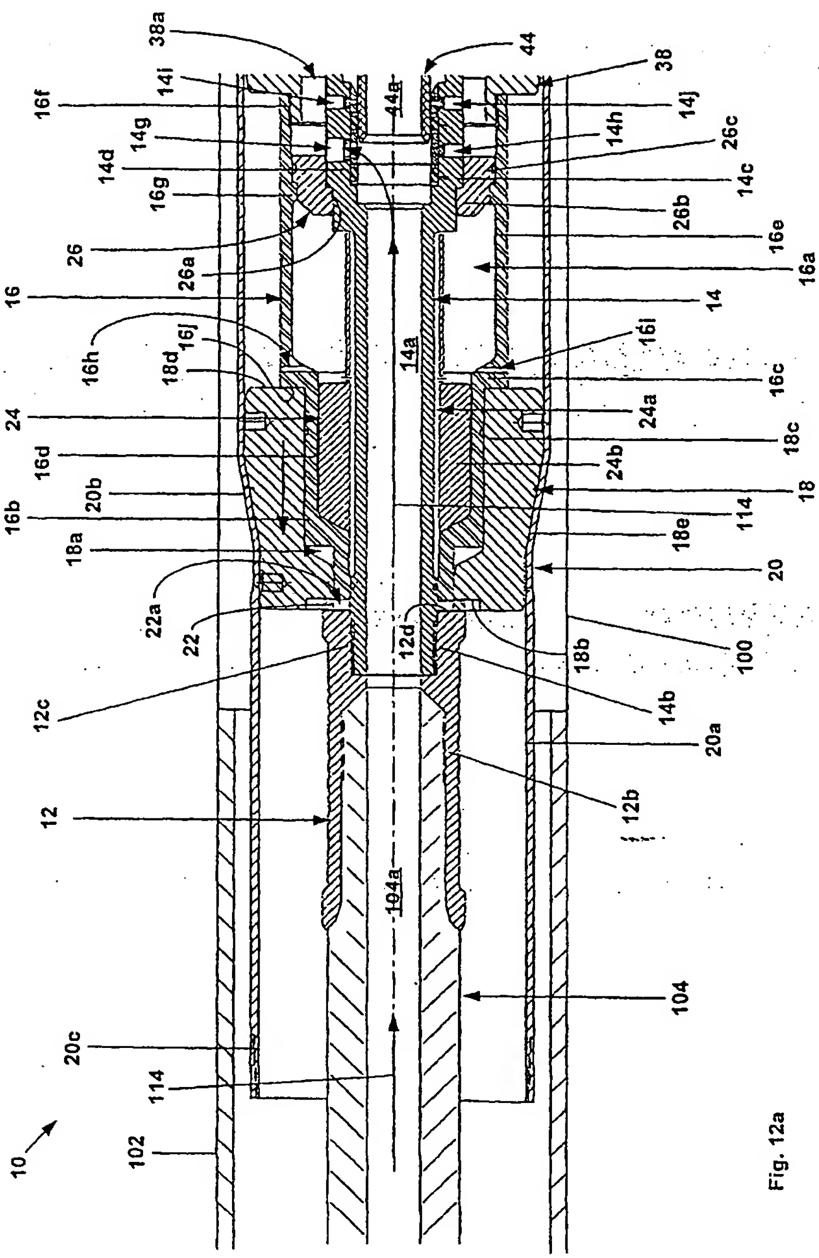

250
A
INJECT AND POSITION TOP PLUG INTO LINER HANGER ASSEMBLY
264
CLOSE SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
266
INJECT NON-HARDENABLE FLUIDIC MATERIALINTO LINER HANGER ASSEMBLY TO RADIALLY EXPAND EXPANSION LAUNCHER
268

Fig. 11b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38
16f
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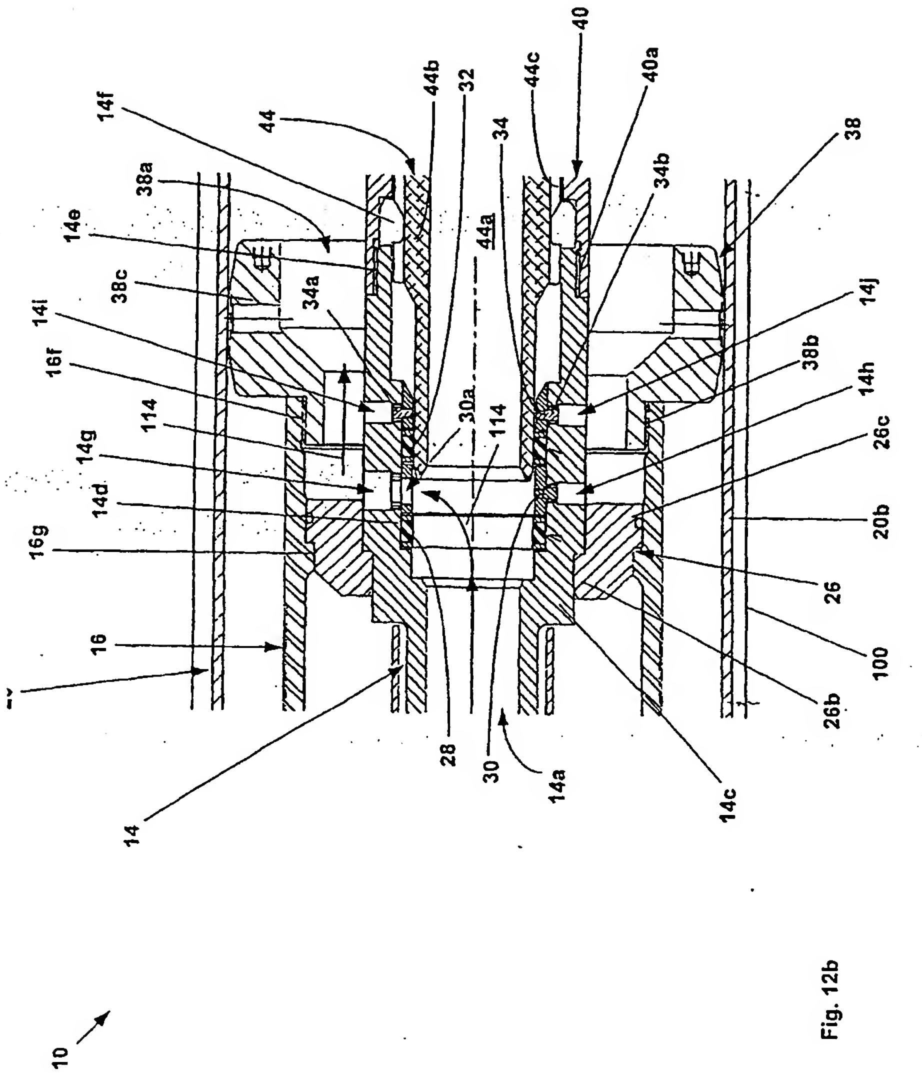
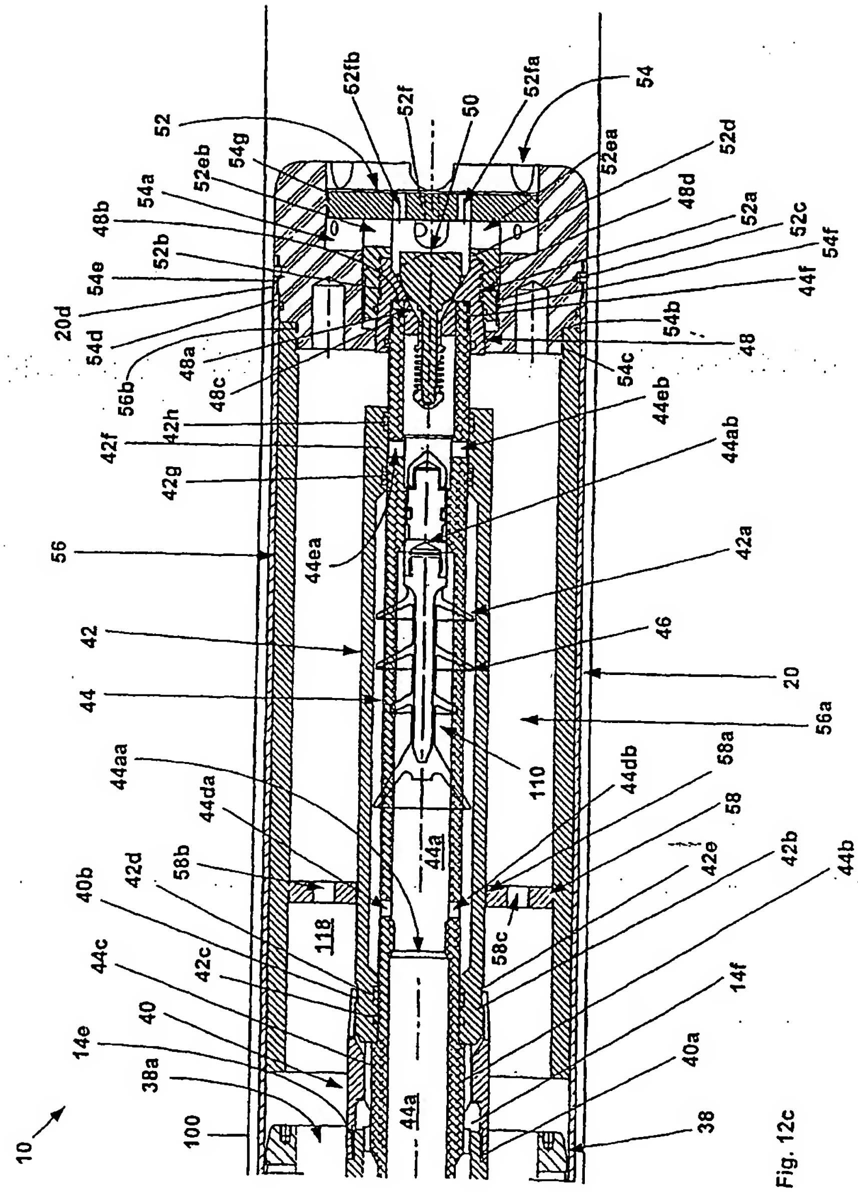
44a
14j
14g
14h
14d
26c
14c
16g
26b
16e
26
16a
26a
16
14
14a
16h
16j
16i
18d
16c
24
24a
18c
16d
24b
20b
18
114
16b
18e
18a
20
22a
22
12d
18b
100
12c
14b
20a
12
12b
104a
104
20c
114
10
102

Fig. 12a



14f
44
44b
32
34
44c
40
40a
34b
38
38a
14e
44a
38c
34a
14i
16f
114
30a
114
14j
38b
14h
26c
14g
14d
20b
16g
26
16
100
26b
14c
14a
30
28
14
10

Fig. 12b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40b
42d
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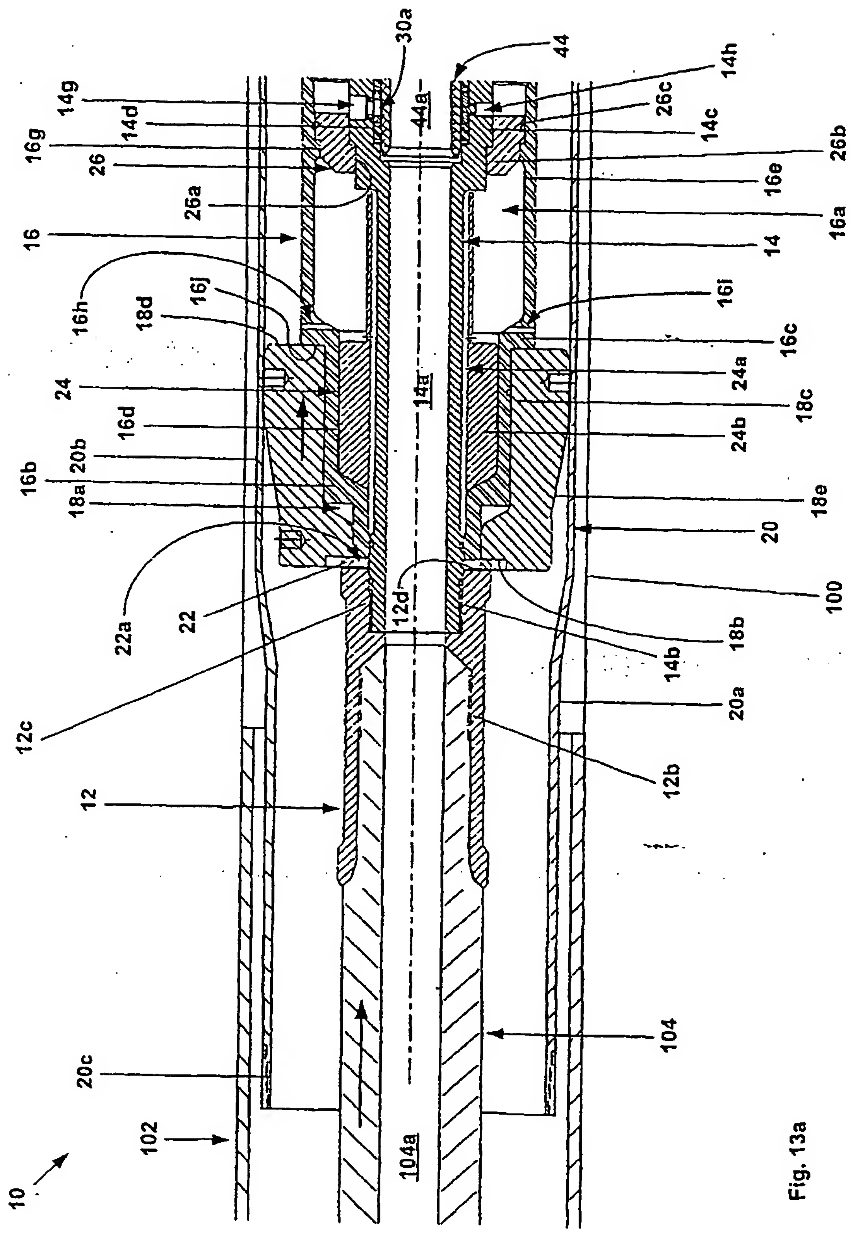
44da
44aa
44
42
56
42g
42f
42h
56b
48c
48a
54d
20d
54e
52b
48b
54a
52eb
54g
52
52fb
52f
50
52fa
54
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
42a
46
20
56a
44db
58a
58
42e
42b
44b
14f
40a
38
44ea
110
44a
118
58c

Fig. 12c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102
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104a
20c
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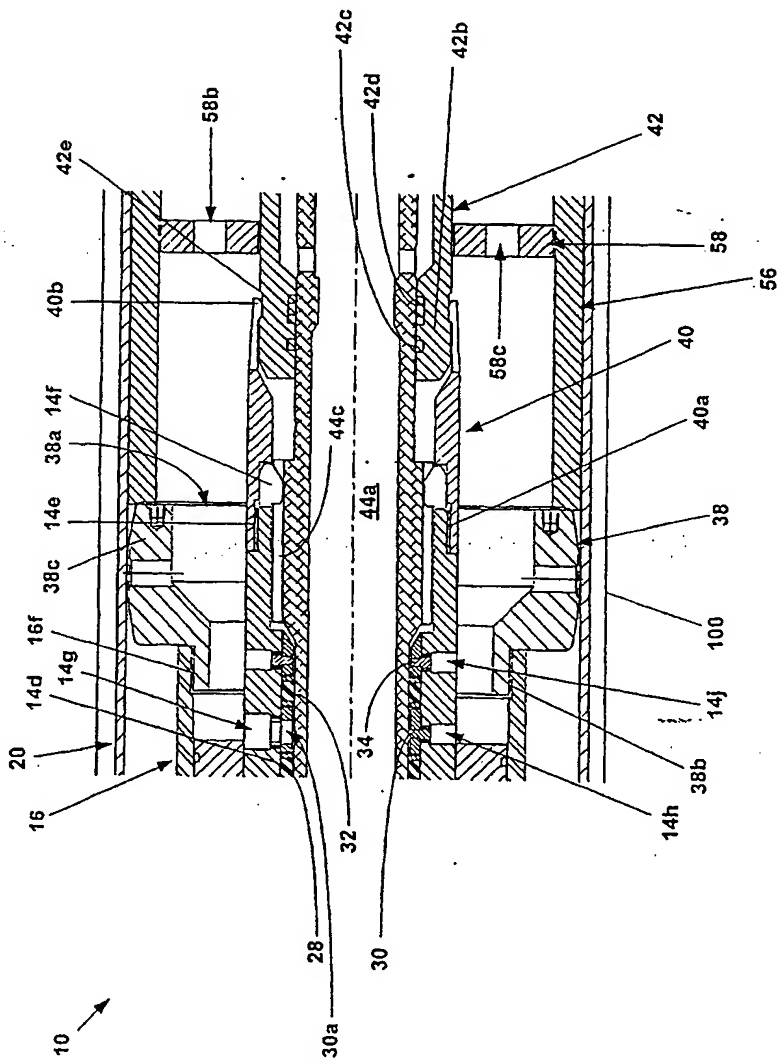
12c
22a
22
16b
20b
18a
16d
24
18d
16h
16j
16
26a
26
16g
14d
14g
30a
44a
44
14h
26c
14c
26b
16e
16a
14
16i
16c
24a
18c
24b
18e
20
100
18b
14b
12d
14a
20a
12b

Fig. 13a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14g
16f
38c
14e
38a
14f
40b
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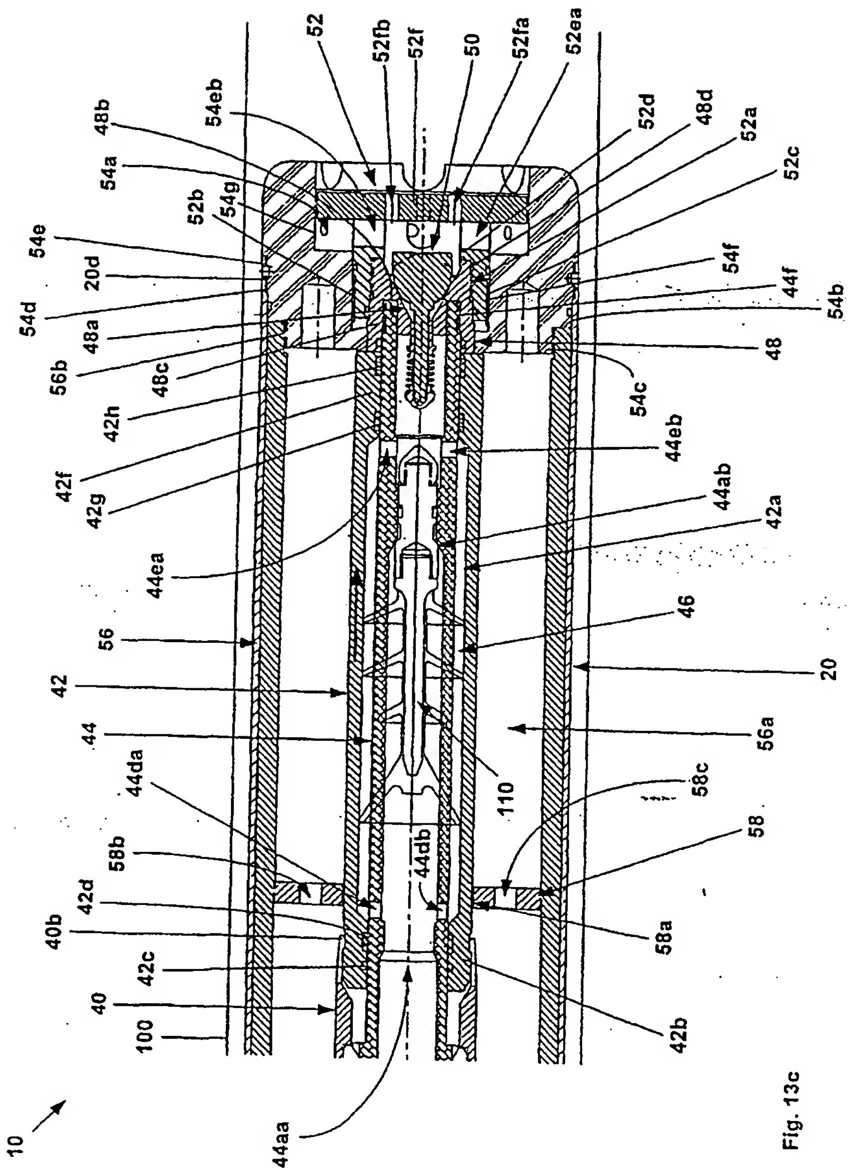
58b
28
30a
32
44c
44a
30
34
42c
42d
42b
42
58
56
58c
40
40a
38
100
14j
38b
14h

Fig. 13b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42d
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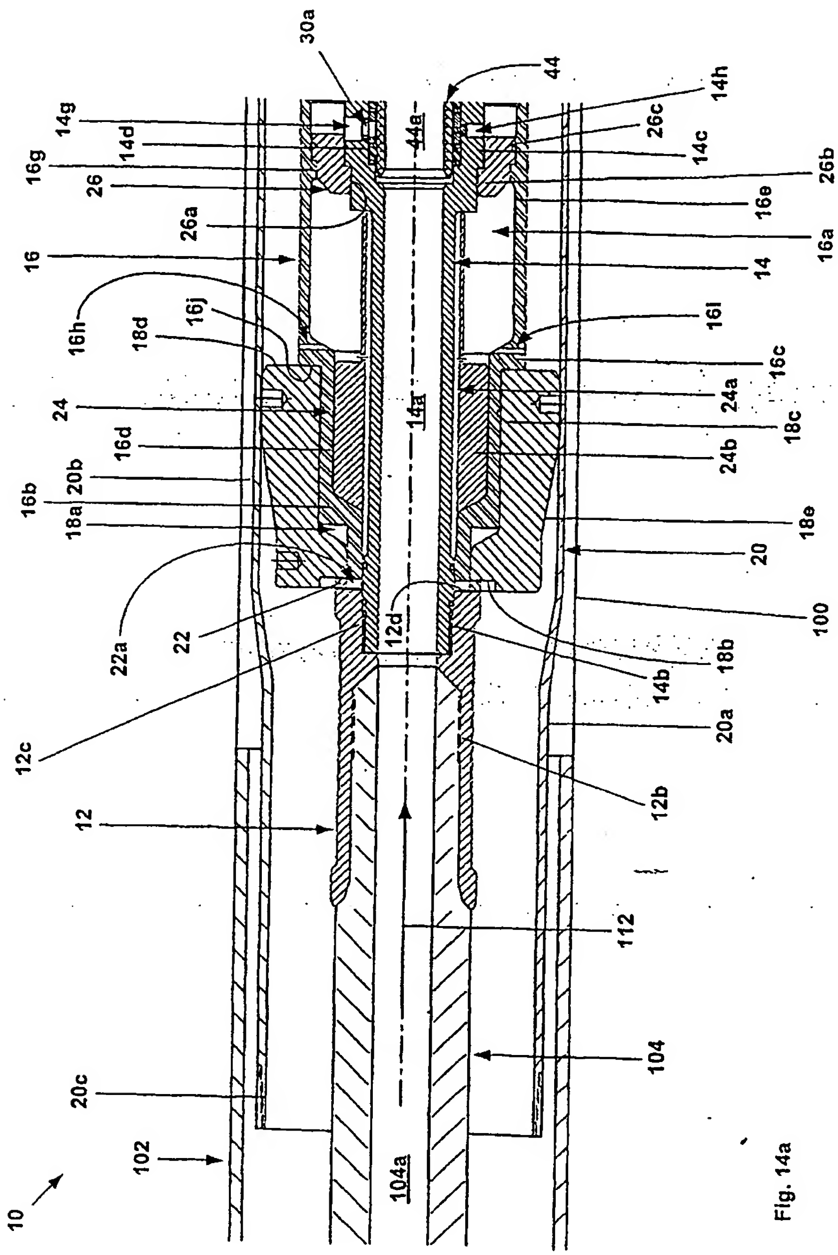
44
42
56
44ea
42g
42f
42h
48c
56b
48a
54d
20d
54e
52b
54g
54a
48b
54eb
52
52fb
52f
50
52fa
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
42a
46
20
56a
110
44db
58c
58
58a
42b

Fig. 13c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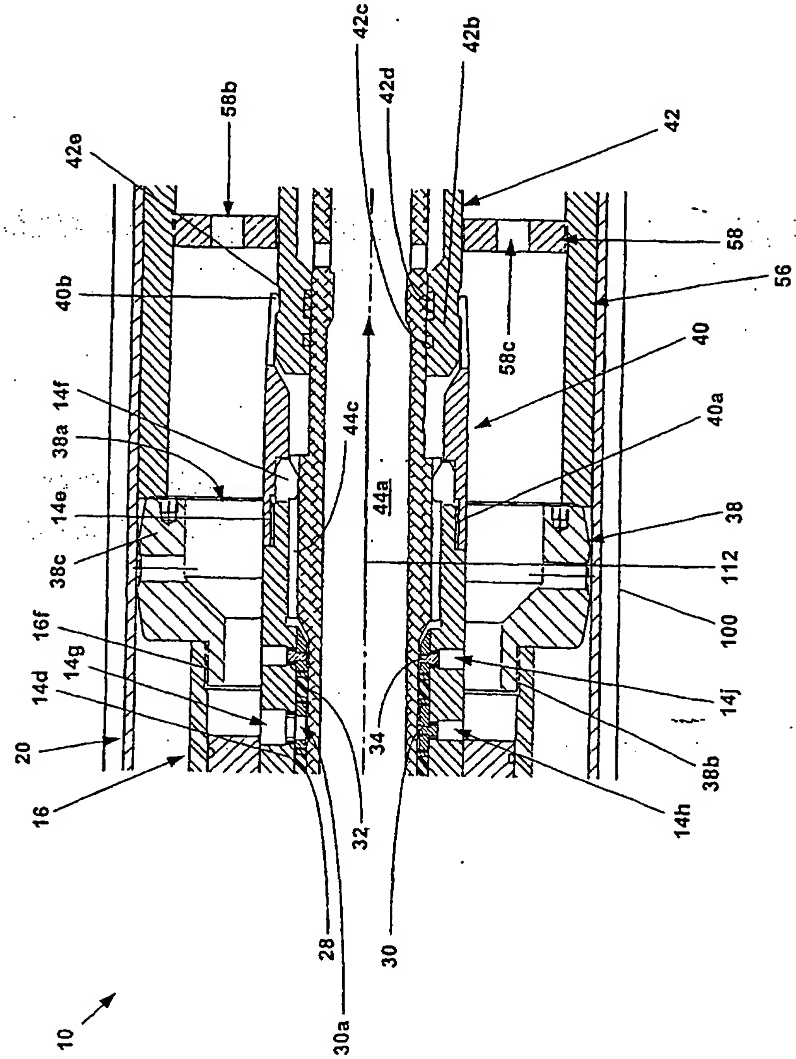
14h
14g
14d
44e
26c
14c
16g
26
26b
16e
26a
16a
16
14
16h
16j
18d
16l
16c
24
14a
24a
18c
16d
24b
20b
16b
18a
18e
20
22a
22
12d
100
18b
14b
12c
20a
12
12b
112
104
20c
102
104a
10

Fig. 14a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16
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14d
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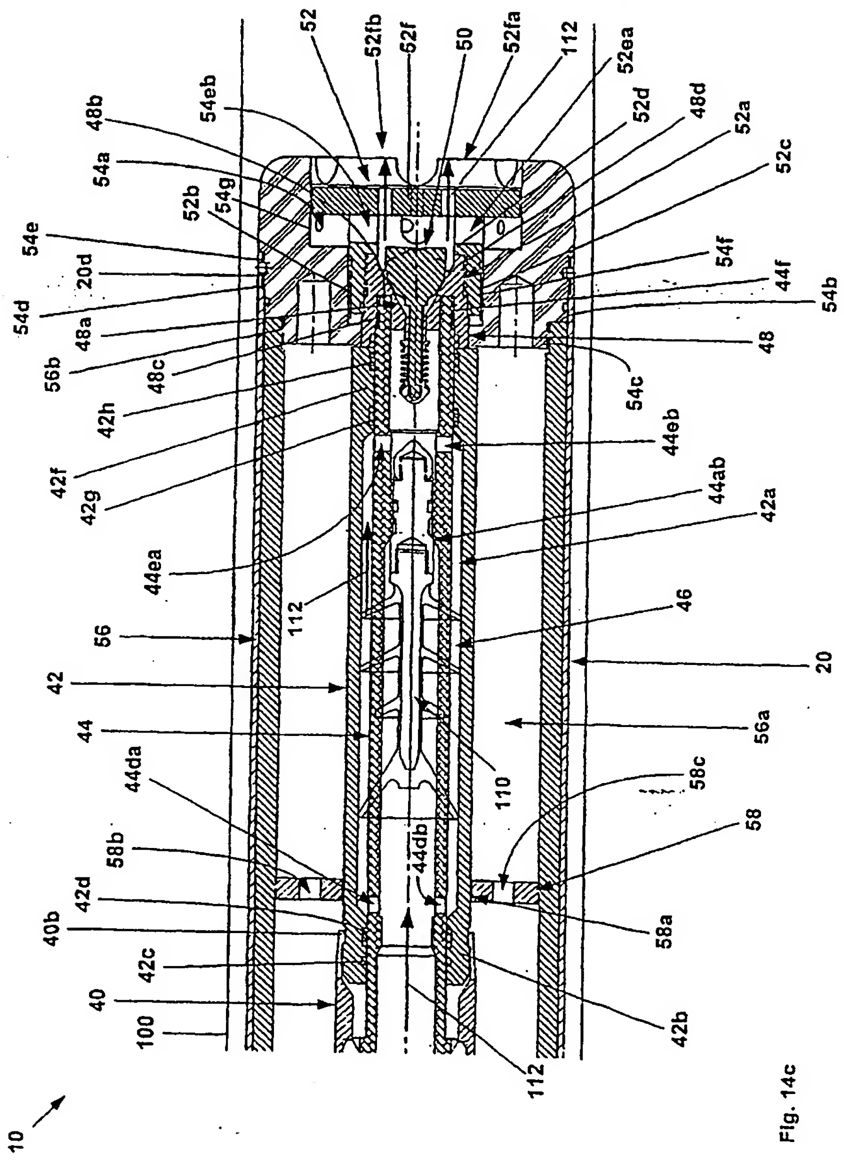
16f
38c
14e
38a
14f
40b
42e
58b
28
30a
32
44c
30
34
44a
42c
42d
42b
42
58
56
58c
40
40a
38
112
100
14j
38b
14h

Fig. 14b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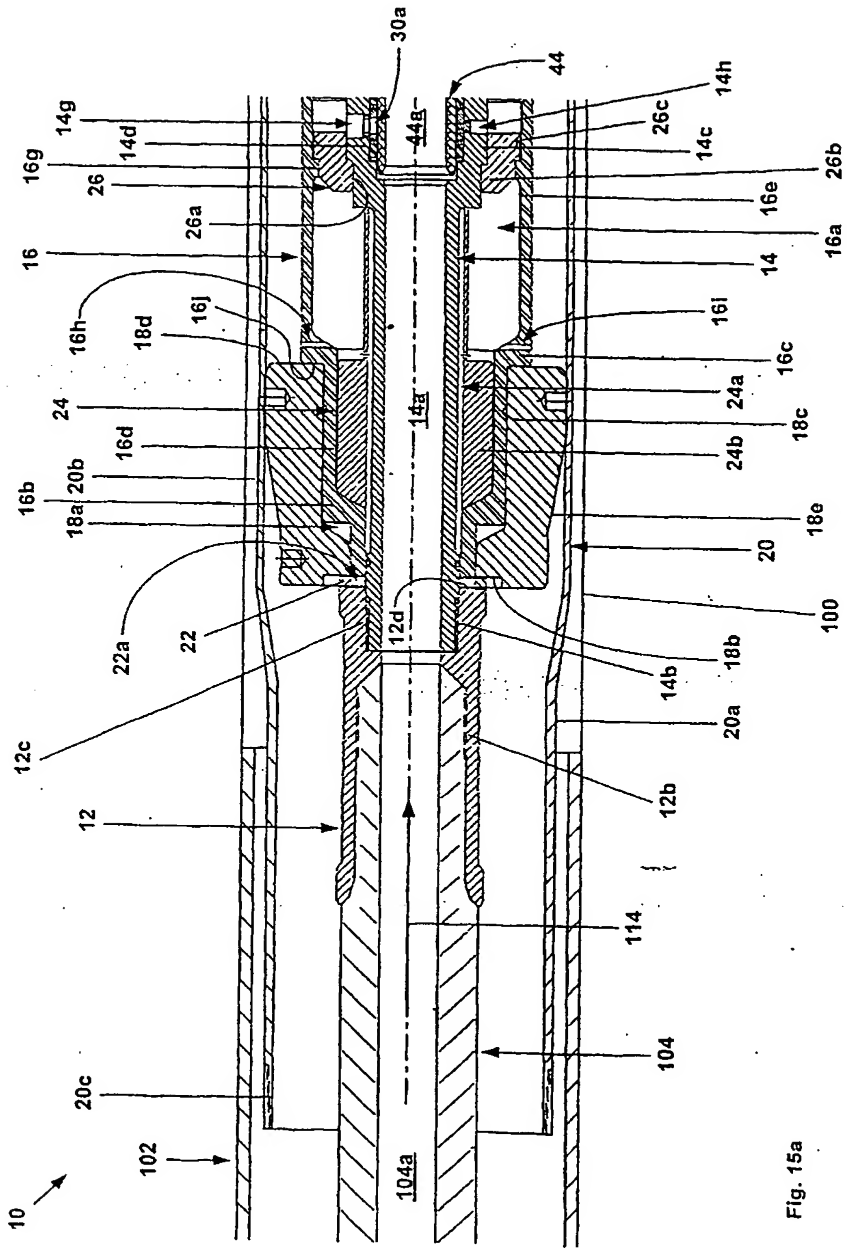
56
44ea
42g
42f
42h
48c
56b
48a
54d
20d
54e
52b
54g
54a
48b
54eb
52
52fb
52f
50
52fa
112
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
42a
46
20
56a
110
44db
58c
58
58a
42b
112

Fig. 14c



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44
44a
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14g
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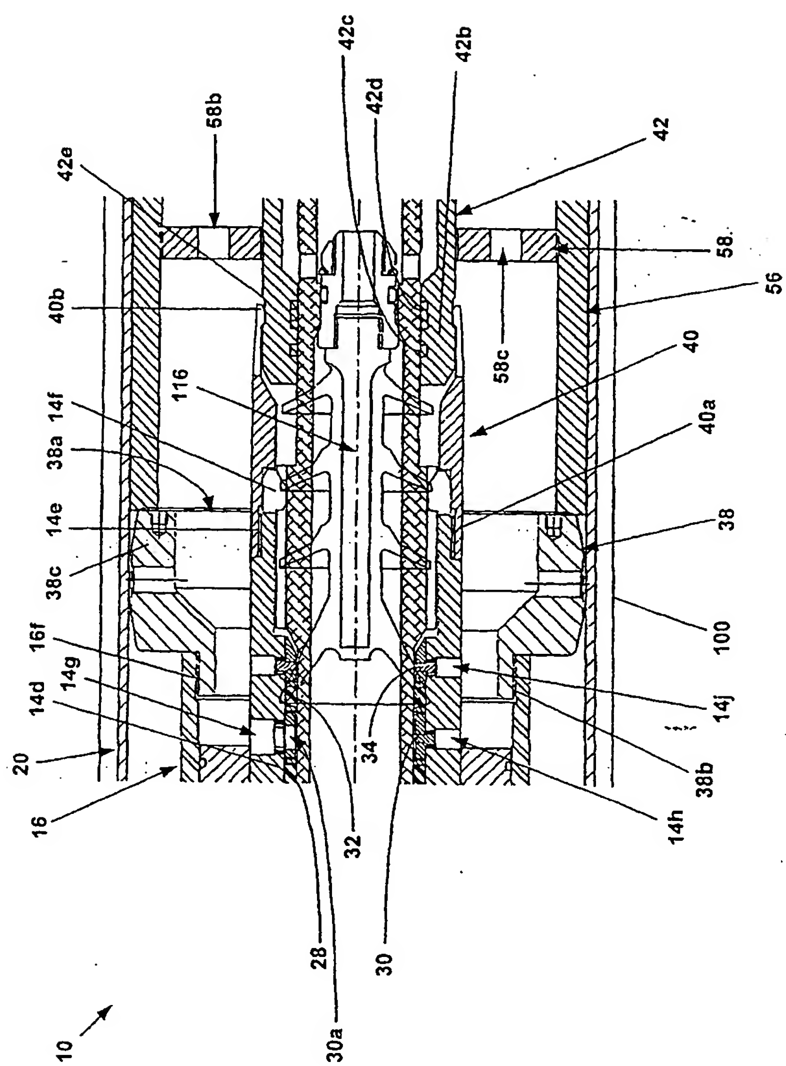
14c
16g
26
26b
16e
26a
16a
16
14
16h
16j
16i
18d
16c
24
24a
14a
18c
16d
24b
16b
20b
18a
18e
20
22a
22
12d
100
18b
14b
12c
20a
12
12b
114
104
20c
102
104a
10

Fig. 15a



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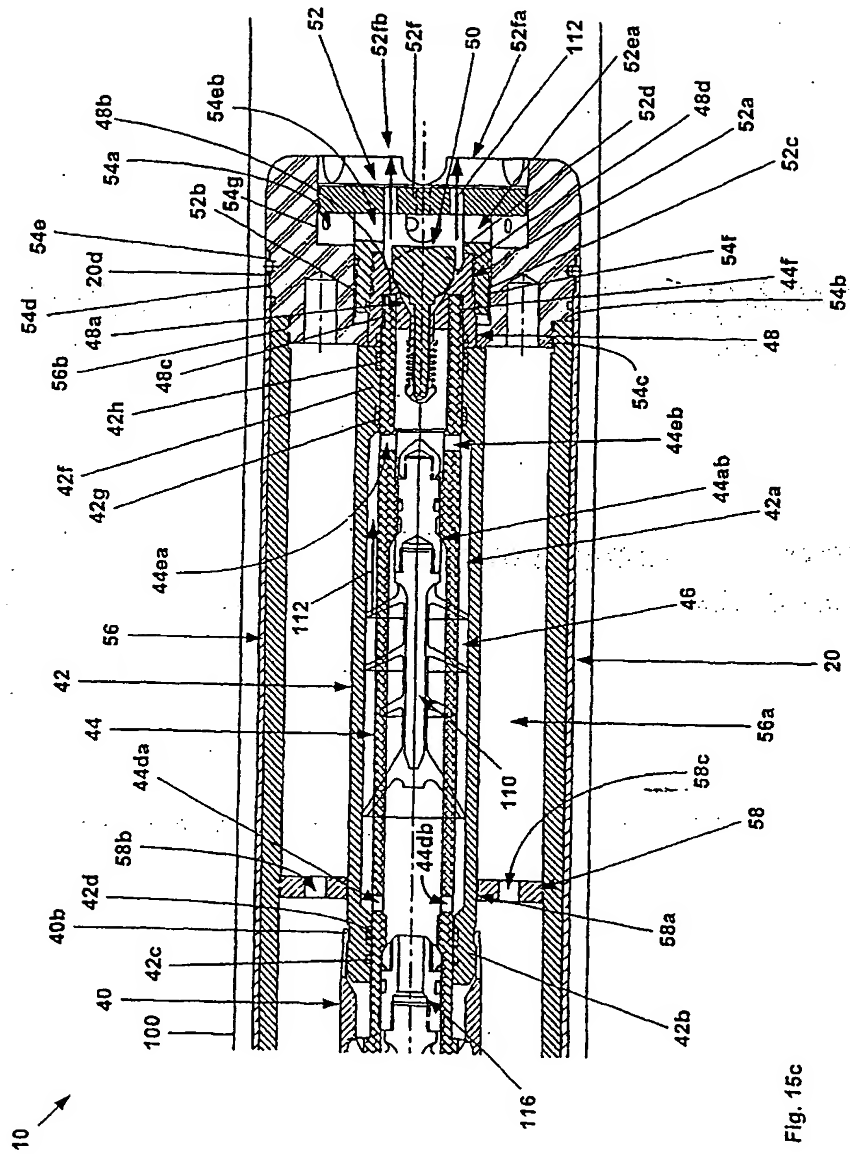
16
20
14d
14g
16f
38c
14e
38a
14f
40b
42e
58b
116
42c
42d
42b
42
58
56
58c
40
40a
38
100
14j
38b
14h
34
32
28
30a
30

Fig. 15b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44
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56
44ea
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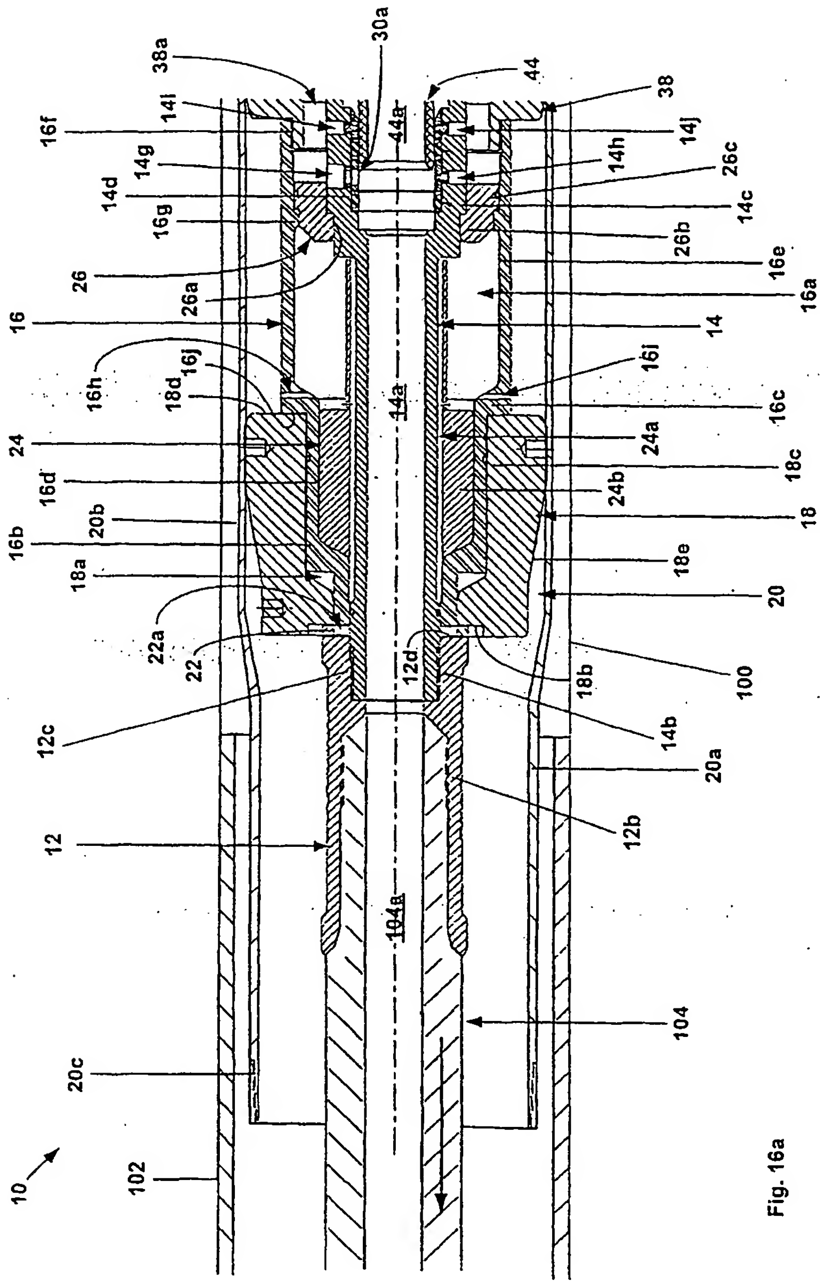
42f
42h
56b
48c
48a
54d
20d
54e
52b
54g
54a
48b
54eb
52
52fb
52f
50
52fa
112
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
42a
112
46
20
110
56a
58c
58
44db
58a
42b
116

Fig. 15c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102
20c
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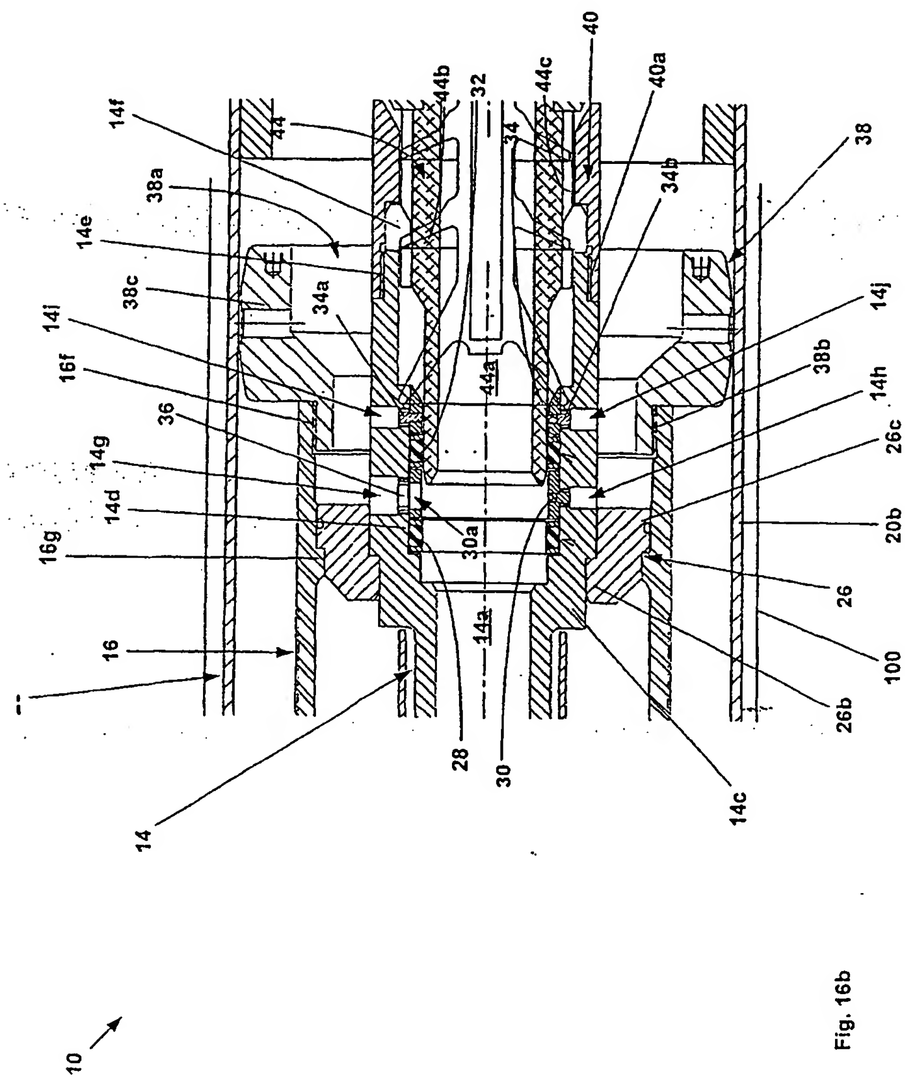
12c
22
22a
18a
16b
20b
16d
24
18d
16j
16h
16
26a
26
16g
14d
14g
16f
14i
38a
30a
44a
44
38
14j
14h
26c
14c
26b
16e
16a
14
16i
16c
14a
24a
18c
24b
18
18e
20
12d
18b
100
14b
20a
12b
104a
104

Fig. 16a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38c
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14i
16f
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14g
14d
16g
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14
44
44b
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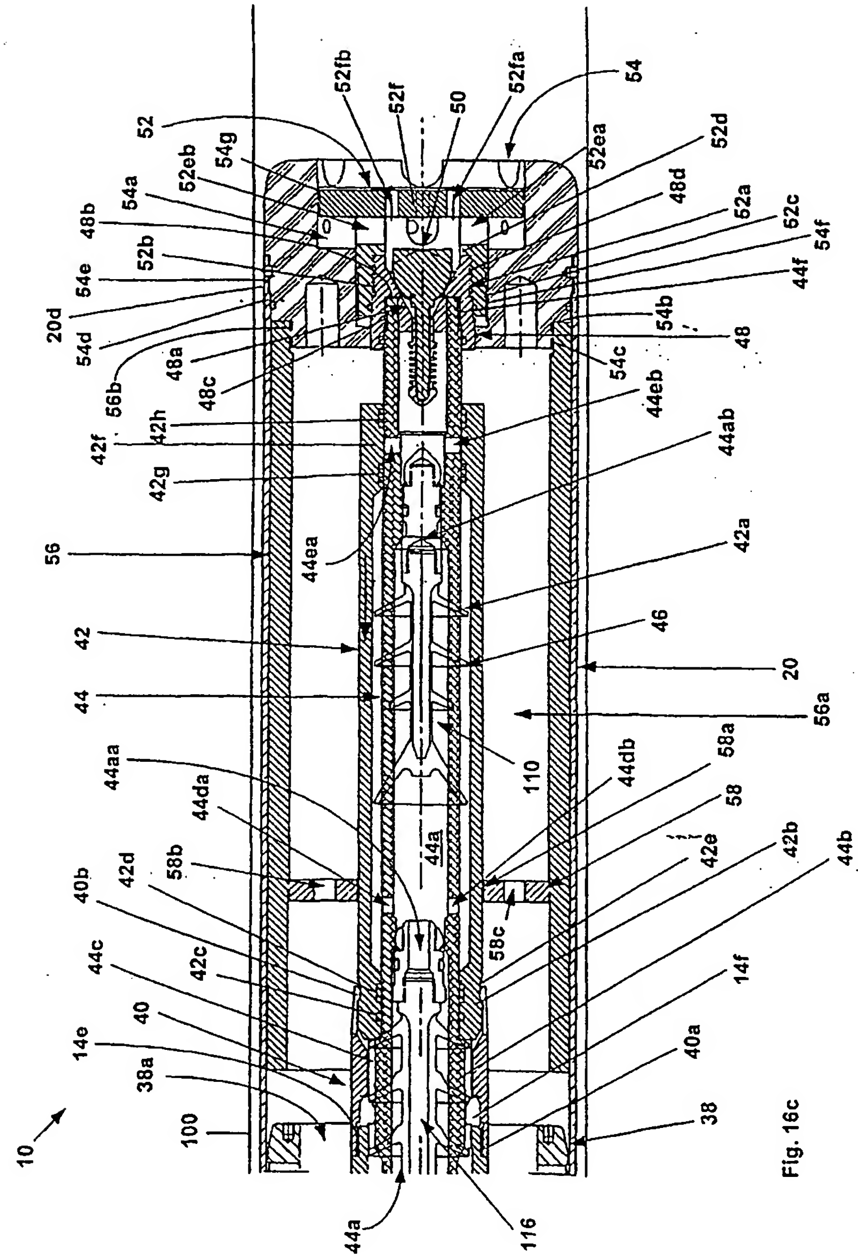
44a
30a
14a
28
30
34
44c
40
40a
34b
38
14j
38b
14h
26c
20b
26
100
26b
14c
10

Fig. 16b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40b
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42
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44ea
42g
42f
42h
56b
48c
48a
54d
20d
54e
52b
48b
54a
52eb
54g
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52fb
52f
50
52fa
54
52ea
52d
48d
52a
52c
54f
44f
54b
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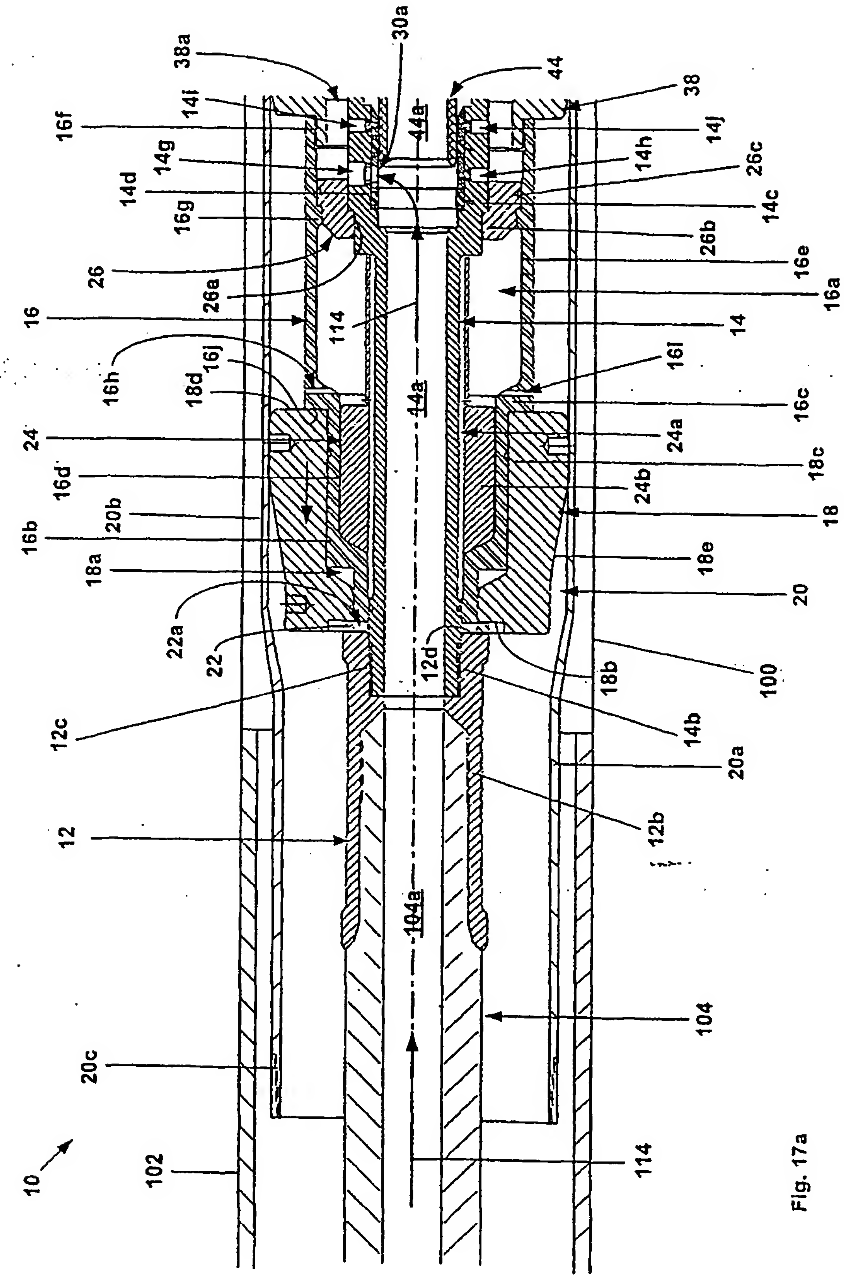
54c
44eb
44ab
42a
46
20
56a
110
44a
44db
58a
58
42e
42b
44b
58c
14f
40a
38
116
44a

Fig. 16c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12c
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16d
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18d
16j
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16
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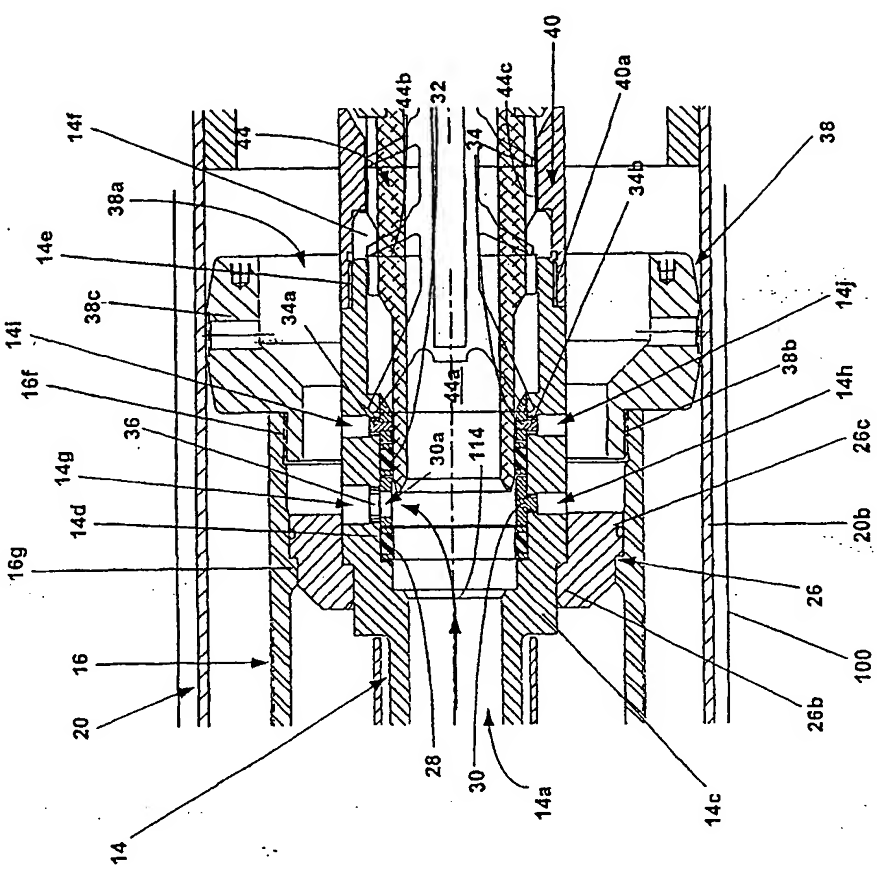
16g
14d
14g
16f
14i
38a
30a
44
44a
38
14j
14h
26c
14c
26b
16e
16a
14
114
14a
16i
16c
24a
18c
24b
18
18e
20
18b
100
12d
14b
20a
12b
104a
104
114

Fig. 17a



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16
28
30
14a
14c
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100
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20b
26c
14h
38b
14j
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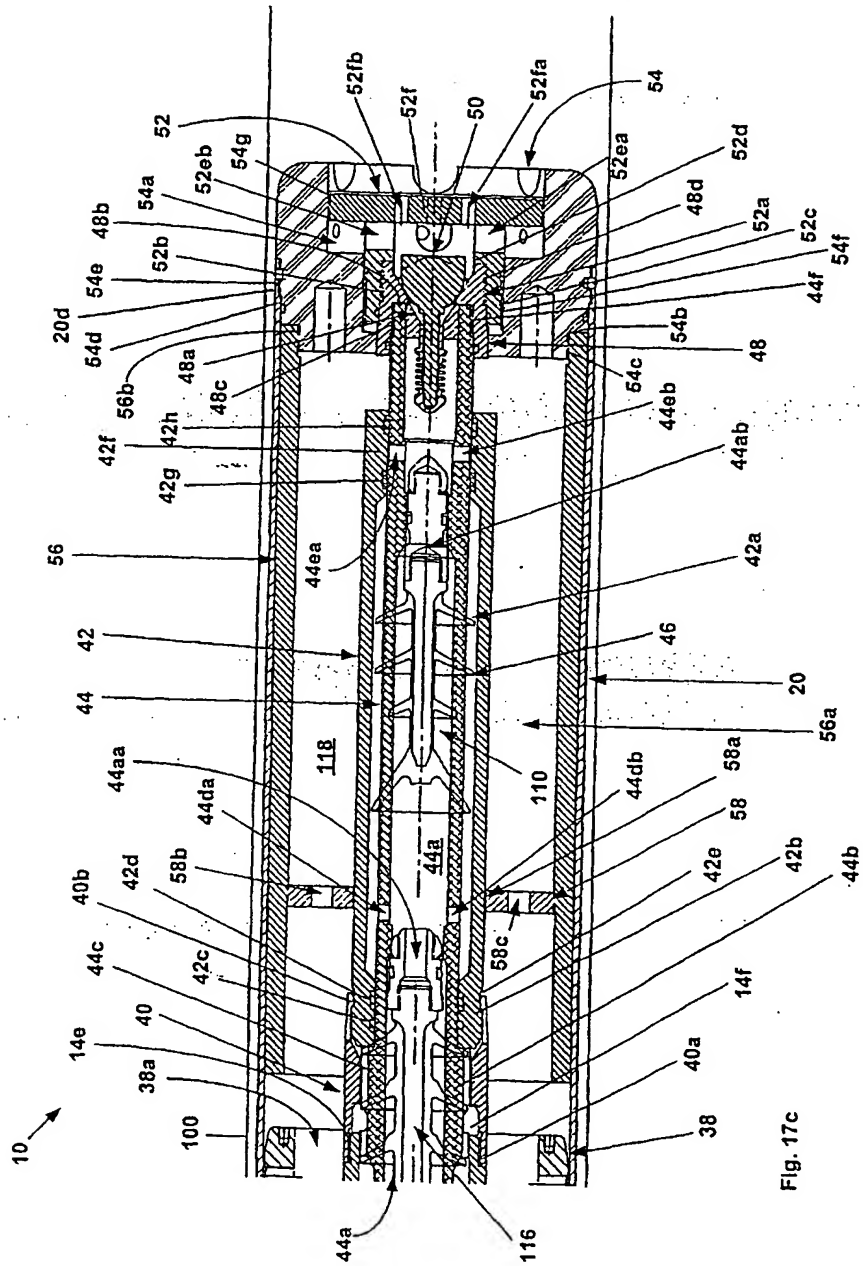
44c
34b
34
32
44b
44
14f
38a
14e
38c
34a
14i
16f
36
14g
14d
16g
30a
114
44a

Fig. 17b



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44c
42c
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42d
58b
44da
44aa
44
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42g
42f
42h
56b
48c
48a
54d
20d
54e
52b
48b
54a
52eb
54g
52
52fb
52f
50
52fa
54
52ea
52d
48d
52a
52c
54f
44f
54b
48
54c
44eb
44ab
44ea
42a
46
20
56a
110
118
44a
44db
58a
58
58c
42e
42b
44b
14f
40a
38
116

Fig. 17c

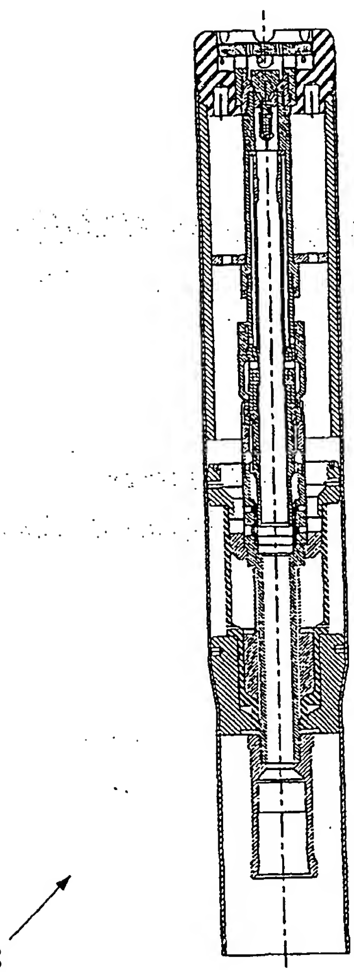
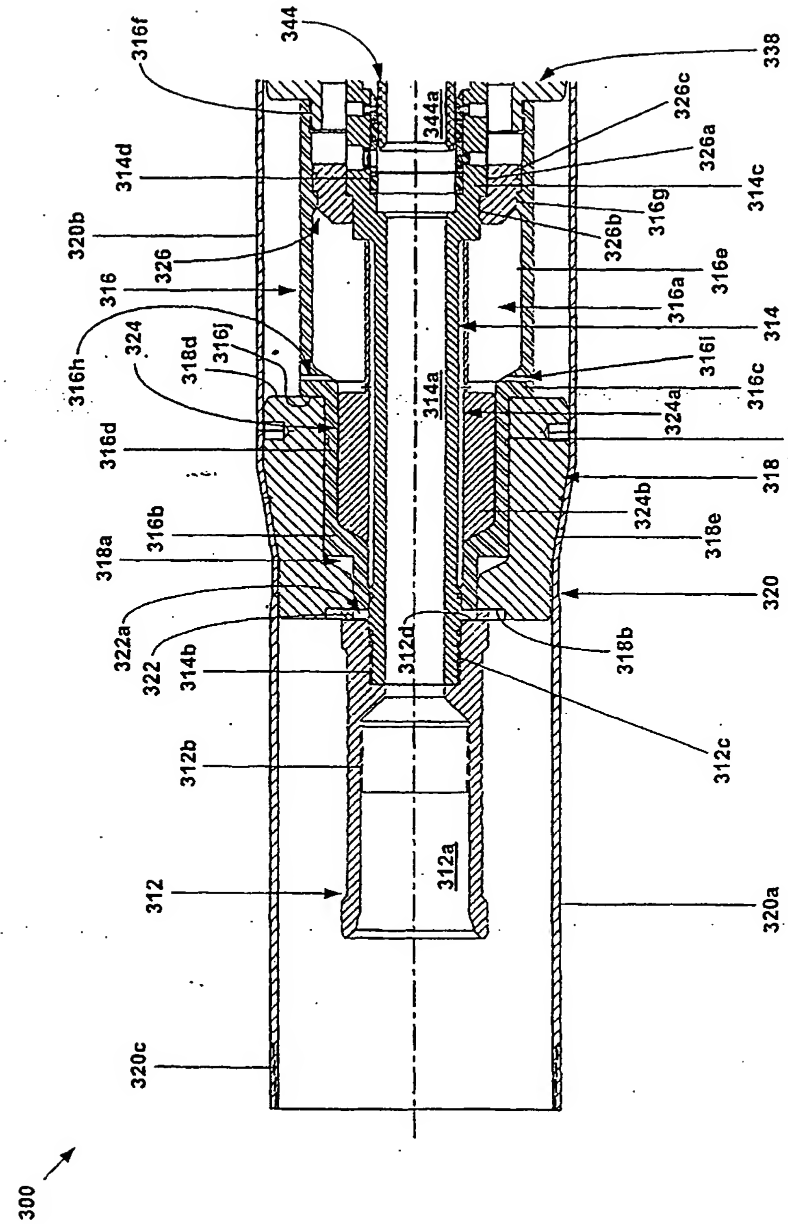


Fig. 18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326b
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316e
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316a
314
316h
324
318d
316j
316i
314a
316c
324a
318c
316d
318
324b
318e
318a
316b
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312d
318b
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314b
312c
312b
312a
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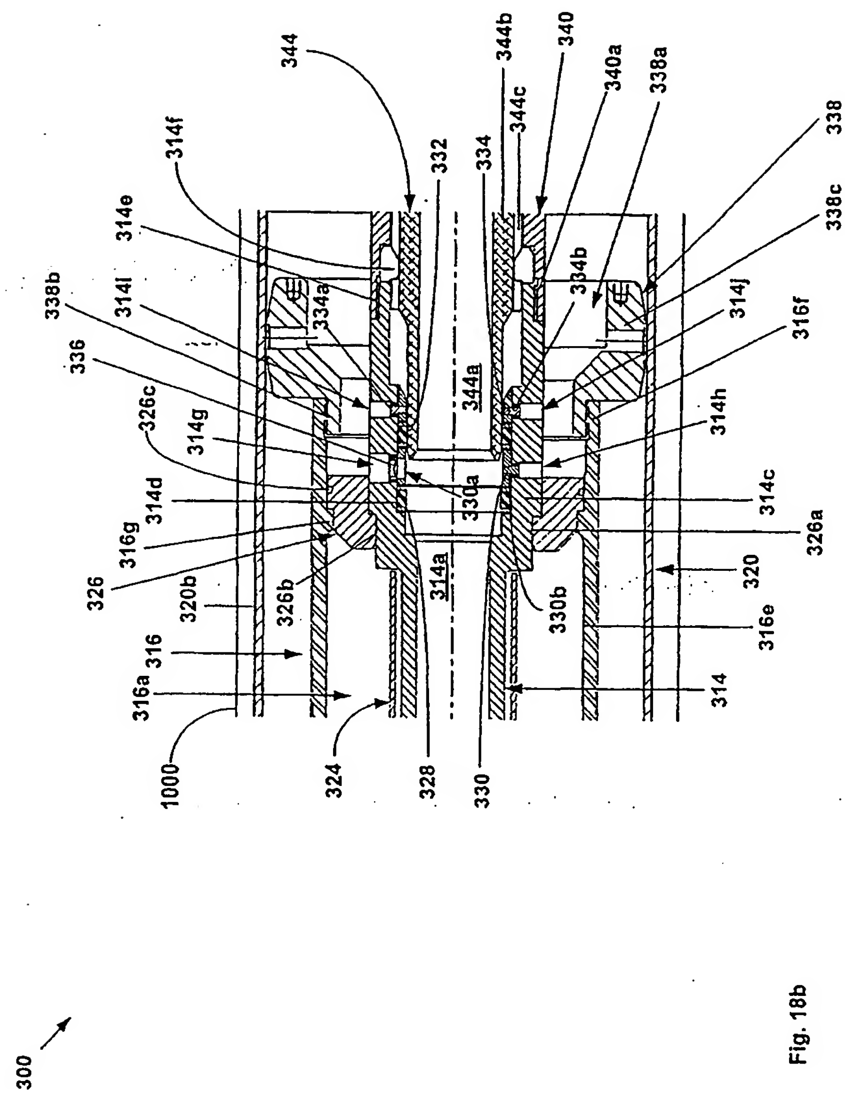
320a
320c
300

Fig. 18a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1000
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316g
314d
326c
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338b
314i
314e
314f
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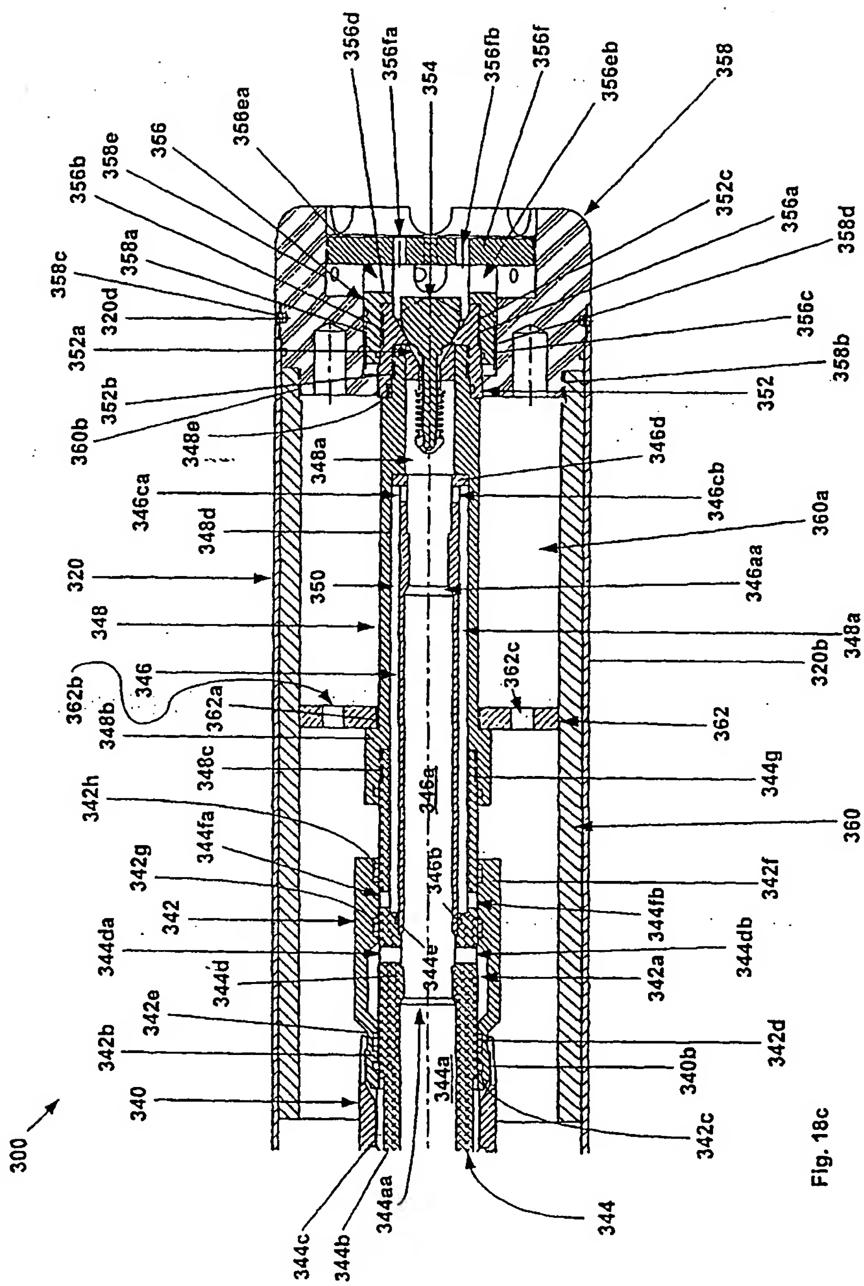
332
334
344b
344c
340
340a
338a
338
338c
334a
334b
314j
316f
314g
314h
330a
344a
314c
326a
326b
314a
330b
320
316e
324
328
330
314

Fig. 18b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346
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346ca
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
348e
348a
348d
350
362a
348c
344fa
344d
344e
346e
346b
344a
344aa
344b
344c
344
346d
346cb
360a
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344fb
344db
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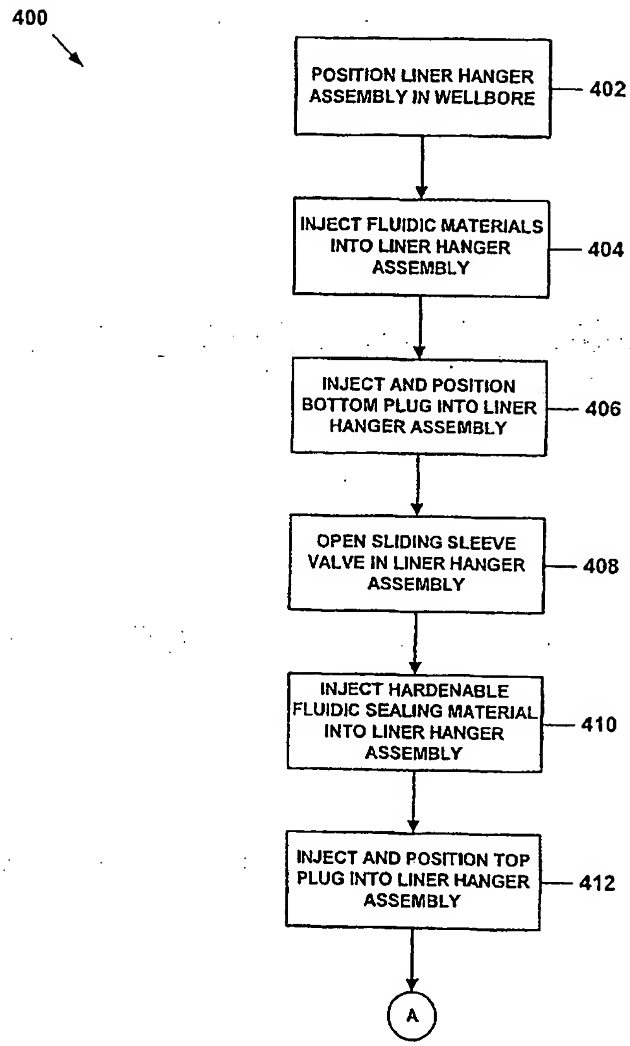
342d
340b
342c

Fig. 18c



400
POSITION LINER HANGER ASSEMBLY IN WELLBORE
402
INJECT FLUIDIC MATERIALS INTO LINER HANGER ASSEMBLY
404
INJECT AND POSITION BOTTOM PLUG INTO LINER HANGER ASSEMBLY
406
OPEN SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
408
INJECT HARDENABLE FLUIDIC SEALING MATERIAL INTO LINER HANGER ASSEMBLY
410
INJECT AND POSITION TOP PLUG INTO LINER HANGER ASSEMBLY
412
A

Fig. 19a

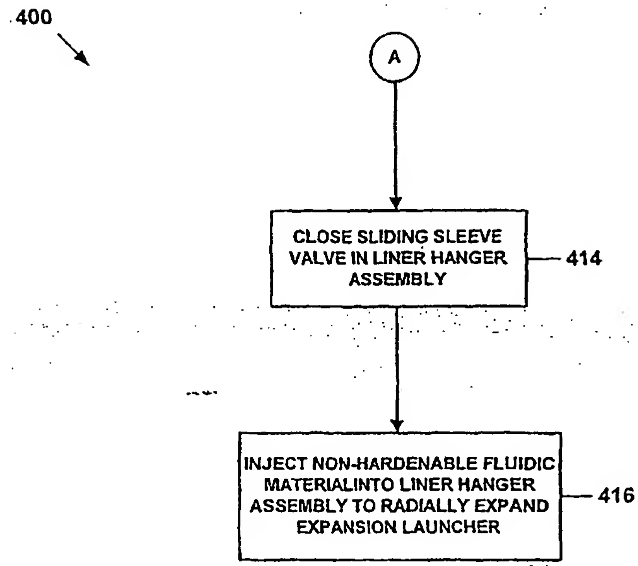
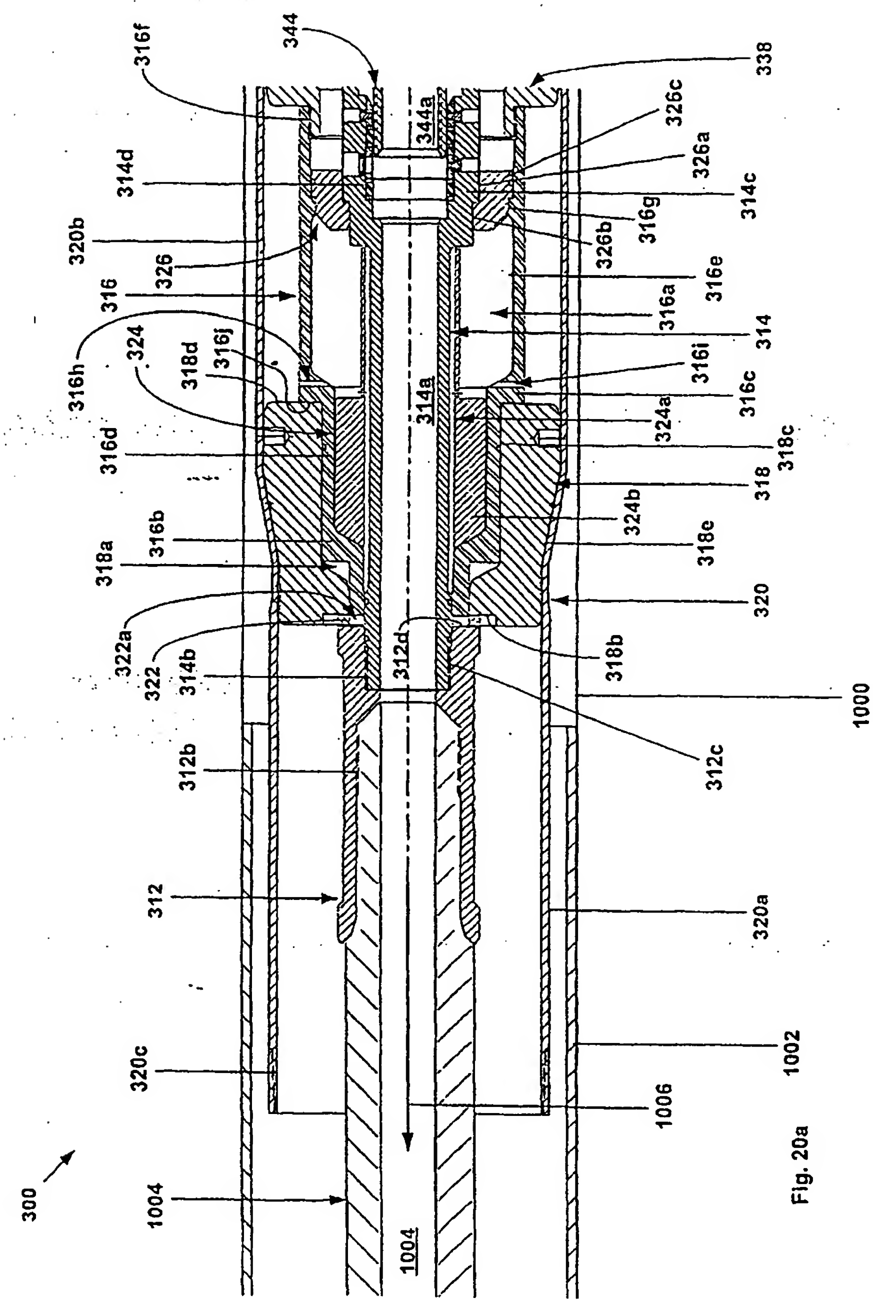

400
A
CLOSE SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
414
INJECT NON-HARDENABLE FLUIDIC MATERIALINTO LINER HANGER ASSEMBLY TO RADIALLY EXPAND EXPANSION LAUNCHER
416

Fig. 19b



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316f
338
344a
326c
326a
314d
314c
316g
320b
326b
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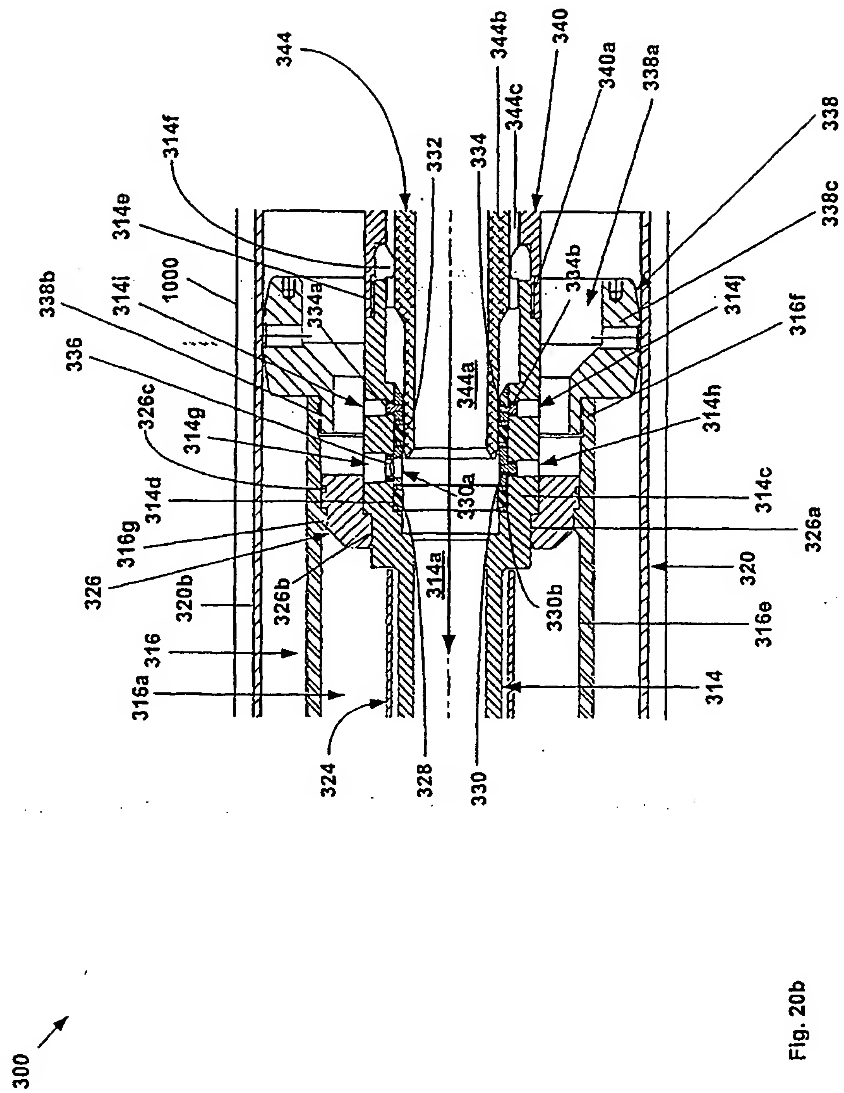
316e
316
316a
314
316h
324
318d
316j
316i
316c
314a
324a
316d
318c
318
324b
316b
318e
318a
320
322a
322
314b
312d
318b
1000
312b
312c
312
320a
320c
1002
1006
300
1004
1004

Fig. 20a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344b
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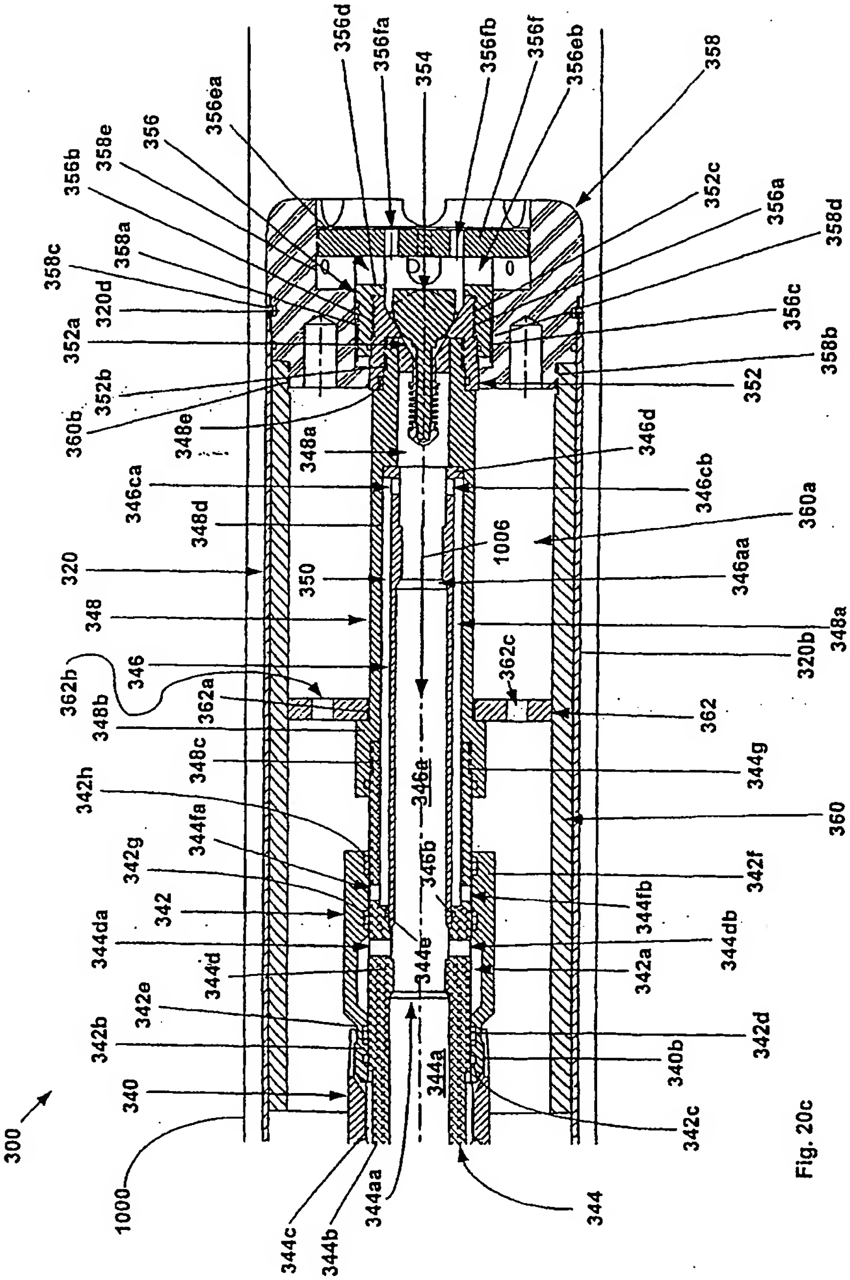
340a
338a
338
338c
314f
332
334
344c
314e
1000
334a
334b
338b
314i
314j
316f
336
344a
326c
314g
314h
314d
330a
314c
316g
326a
326
320b
314a
326b
330b
320
316e
316
316a
314
324
328
330

Fig. 20b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1000
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342b
342e
344d
344da
342
342g
344fa
342h
348c
348b
362a
362b
346
348
320
350
348d
346ca
348a
348e
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
1006
346aa
348a
320b
362c
362
344g
346a
360
342f
344fb
346b
344e
344db
342a
342d
340b
344a
342c
344
344aa
344b
344c

Fig. 20c

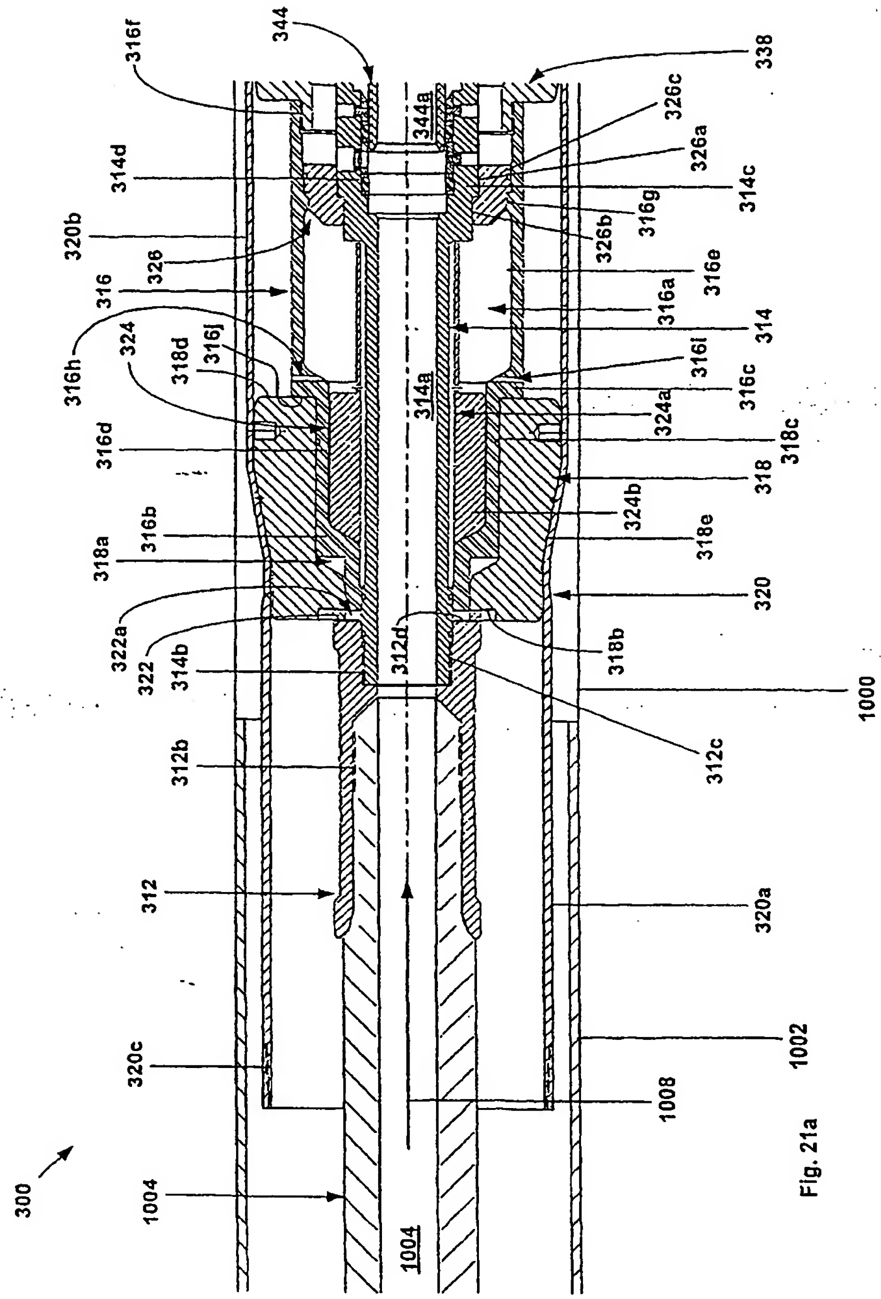

300
316f
344
344a
338
326c
326a
314d
314c
316g
326b
320b
326
316e
316
316a
314
324
316h
318d
316j
316i
316c
314a
324a
318c
316d
318
324b
316b
318e
318a
320
322a
322
312d
318b
314b
1000
312b
312c
312
320a
320c
1002
1008
1004
1004

Fig. 21a

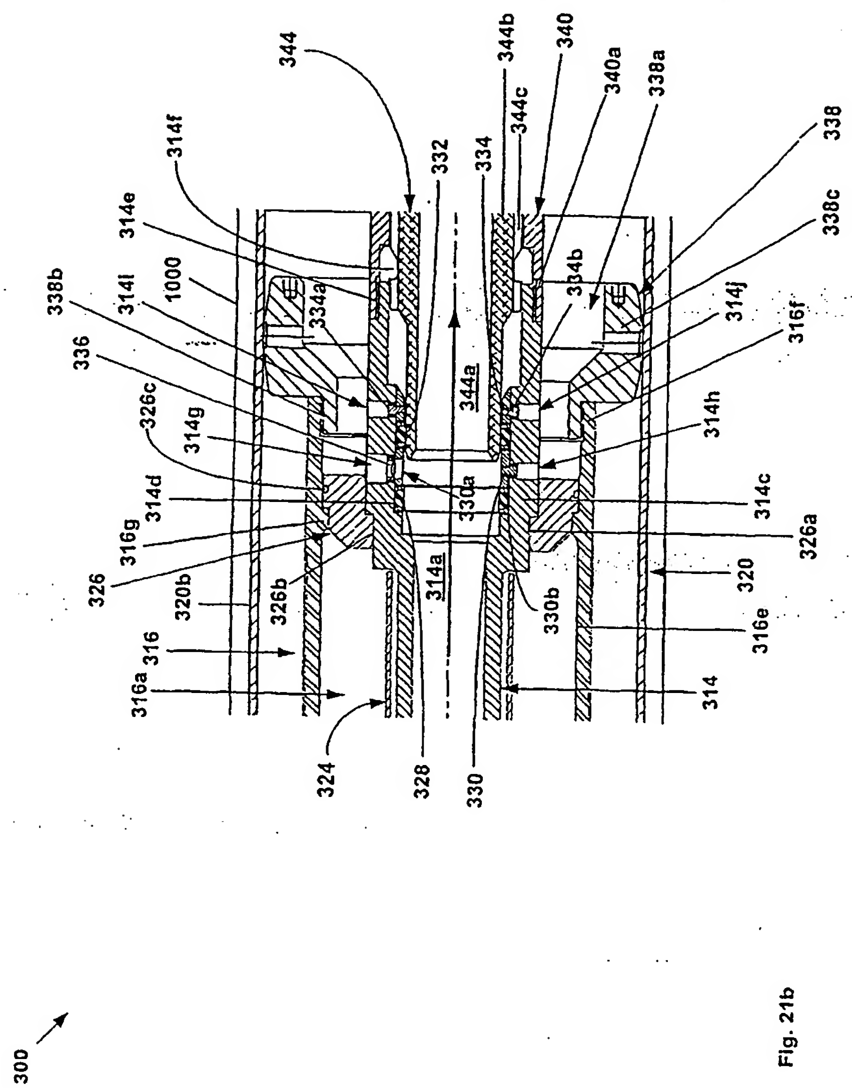

300
344
314f
332
334
344b
344c
340
340a
338a
338
338c
314e
1000
314l
338b
334a
334b
314j
316f
344a
336
326c
314g
314h
330a
314d
314c
316g
326
326a
320b
326b
314a
330b
320
316e
316
316a
314
324
328
330

Fig. 21b

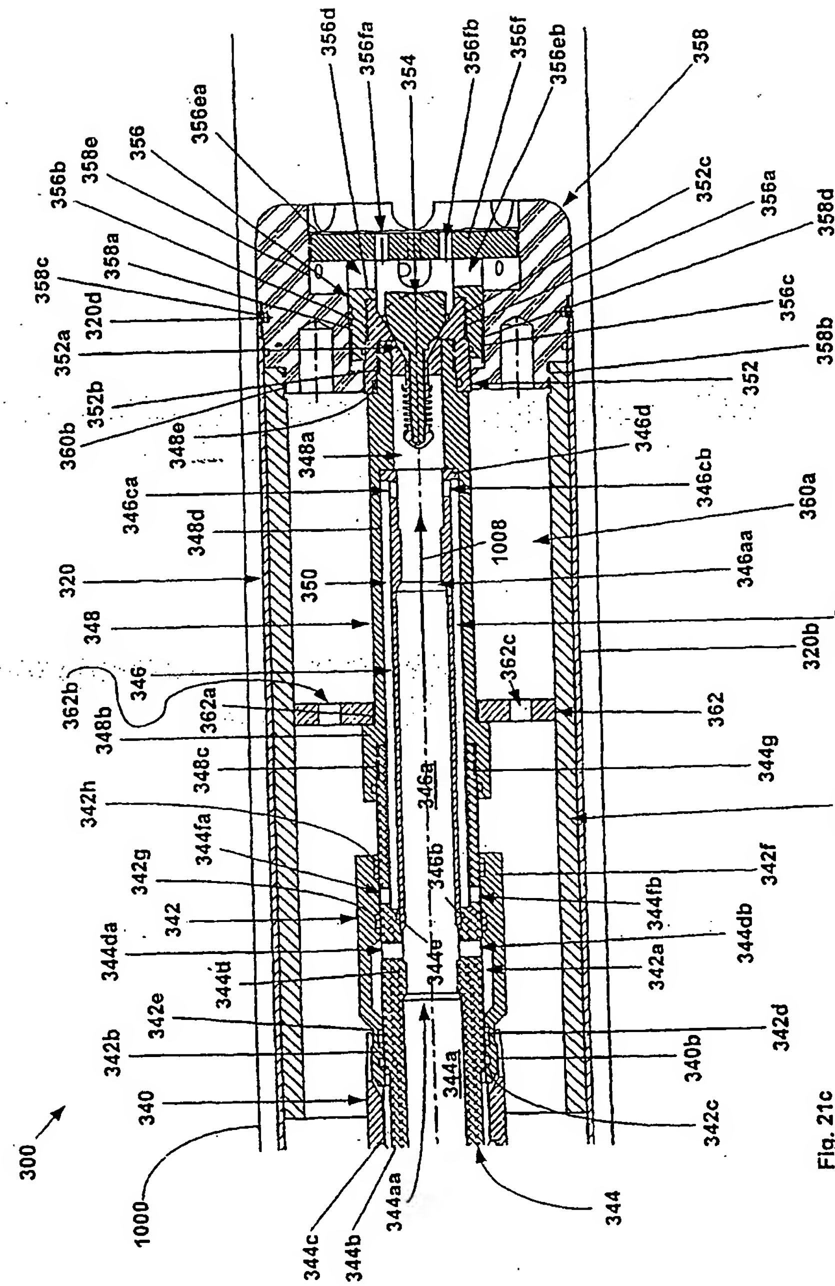
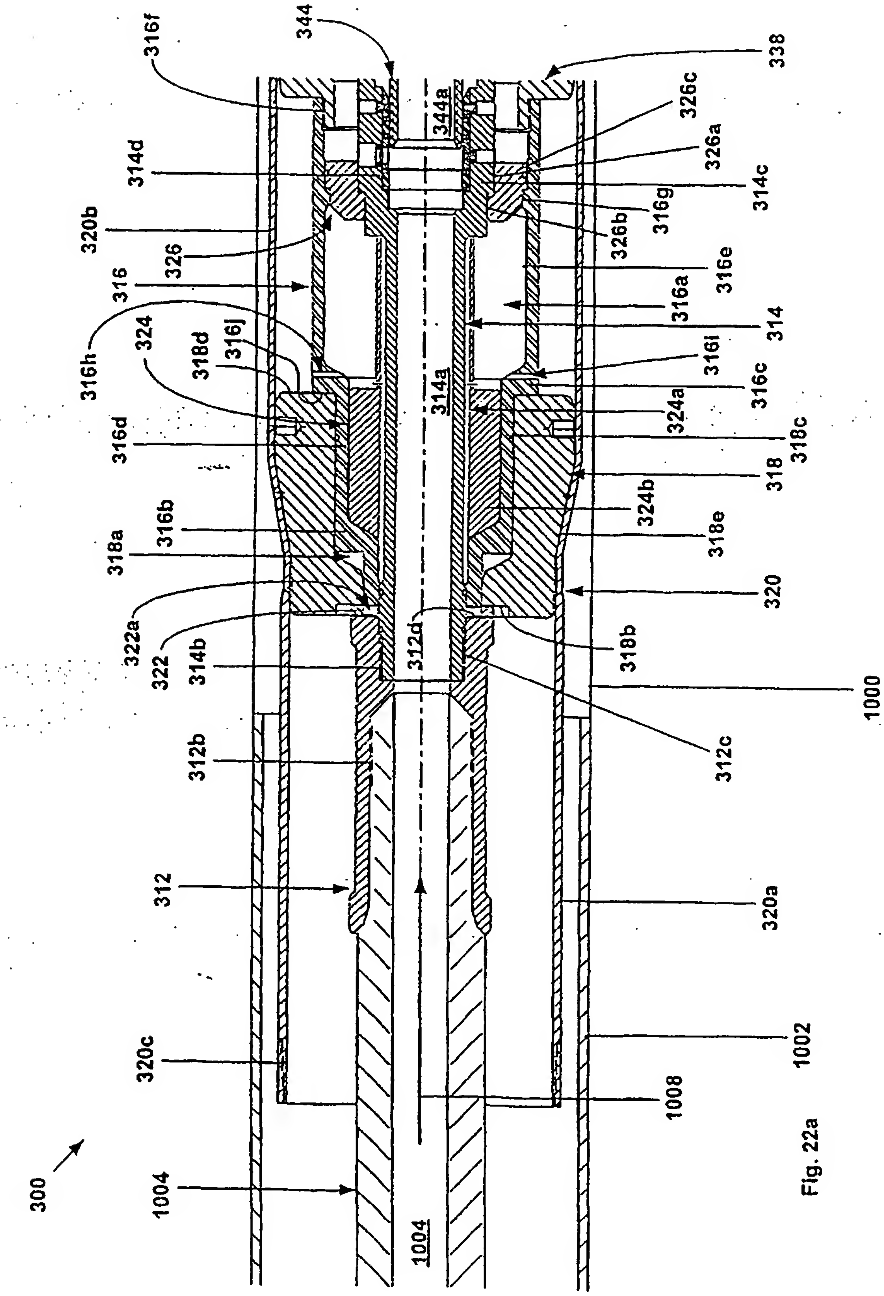

300
1000
320
320b
320d
340
340b
342
342a
342b
342c
342d
342e
342f
342g
342h
344
344a
344aa
344b
344c
344d
344da
344db
344e
344fa
344fb
344g
346
346a
346aa
346b
346ca
346cb
346d
348
348a
348b
348c
348d
348e
350
352
352a
352b
352c
354
356
356a
356b
356c
356d
356ea
356eb
356f
356fa
356fb
358
358a
358b
358c
358d
358e
360
360a
360b
362
362a
362b
362c
1008

Fig. 21c



316f
344
338
344a
326c
326a
314d
314c
316g
320b
326b
326
316e
316
316a
314
316h
324
318d
316j
316i
316c
314a
324a
316d
318c
318
324b
316b
318e
318a
320
322a
322
314b
312d
318b
1000
312c
312b
312
320a
320c
1002
1008
300
1004
1004

Fig. 22a

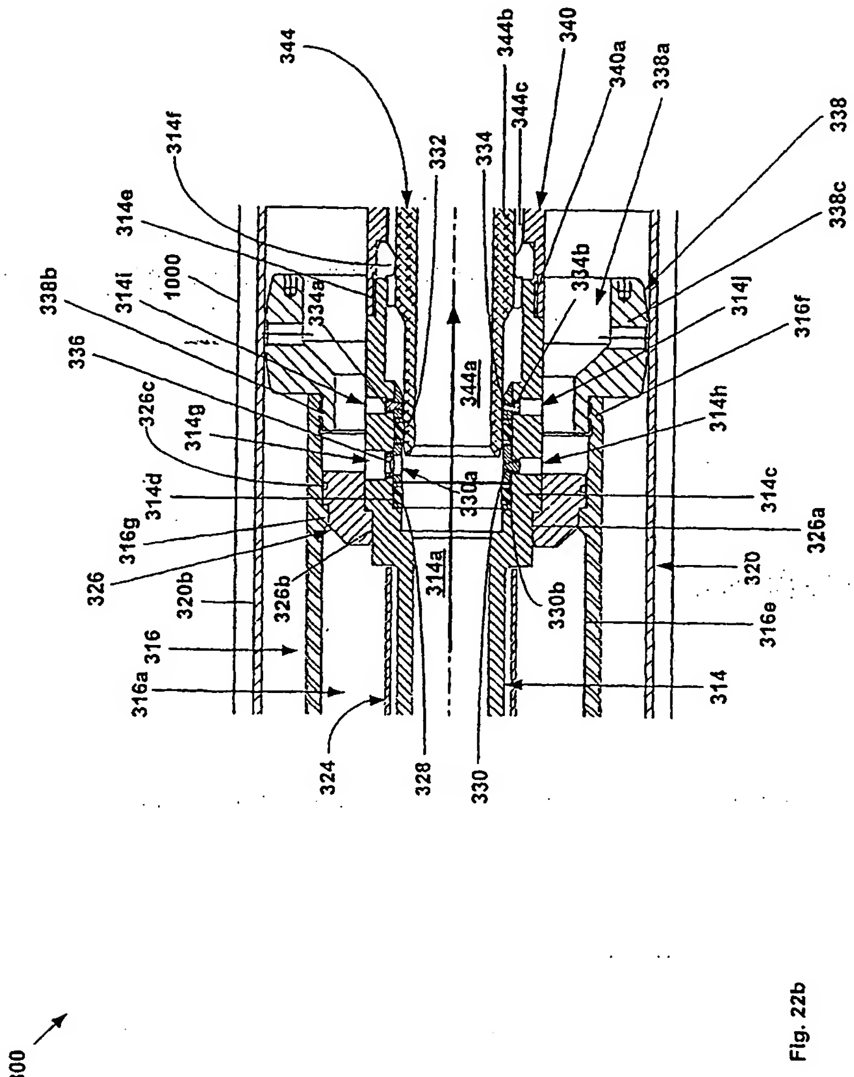

344
344b
340
340a
338a
338
338c
314f
332
334
344c
314e
334b
314j
316f
338b
314i
1000
334a
344a
336
326c
314g
314h
330a
314d
314c
316g
326a
326
326b
314a
330b
320b
320
316
316e
316a
314
324
328
330
300

Fig. 22b

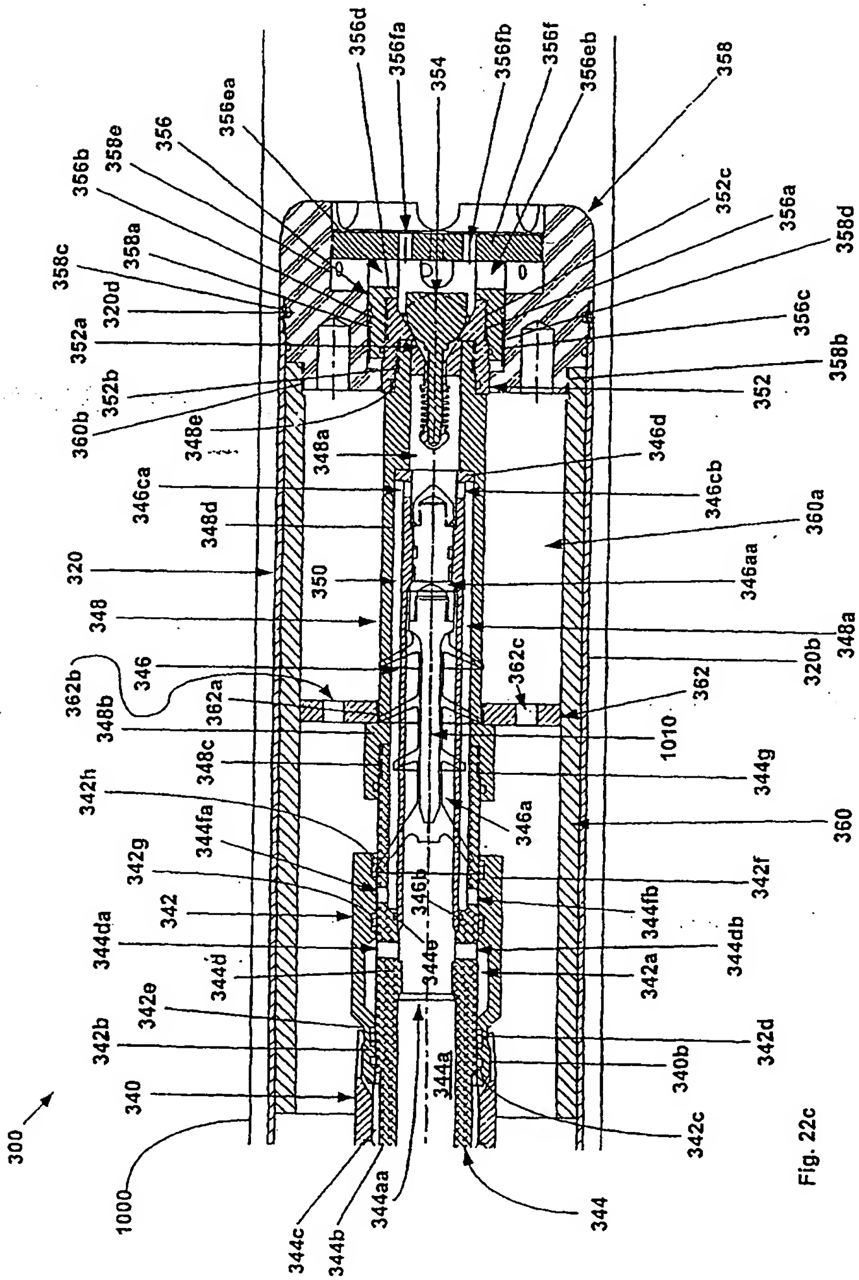

300
1000
340
342b
342e
344d
344da
342
342g
344fa
342h
348c
348b
362b
346
362a
348
320
350
348d
346ca
348e
348a
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
346aa
348a
320b
362c
362
1010
344g
346a
360
342f
346b
344fb
344e
344db
342a
344a
342d
340b
342c
344
344aa
344b
344c

Fig. 22c

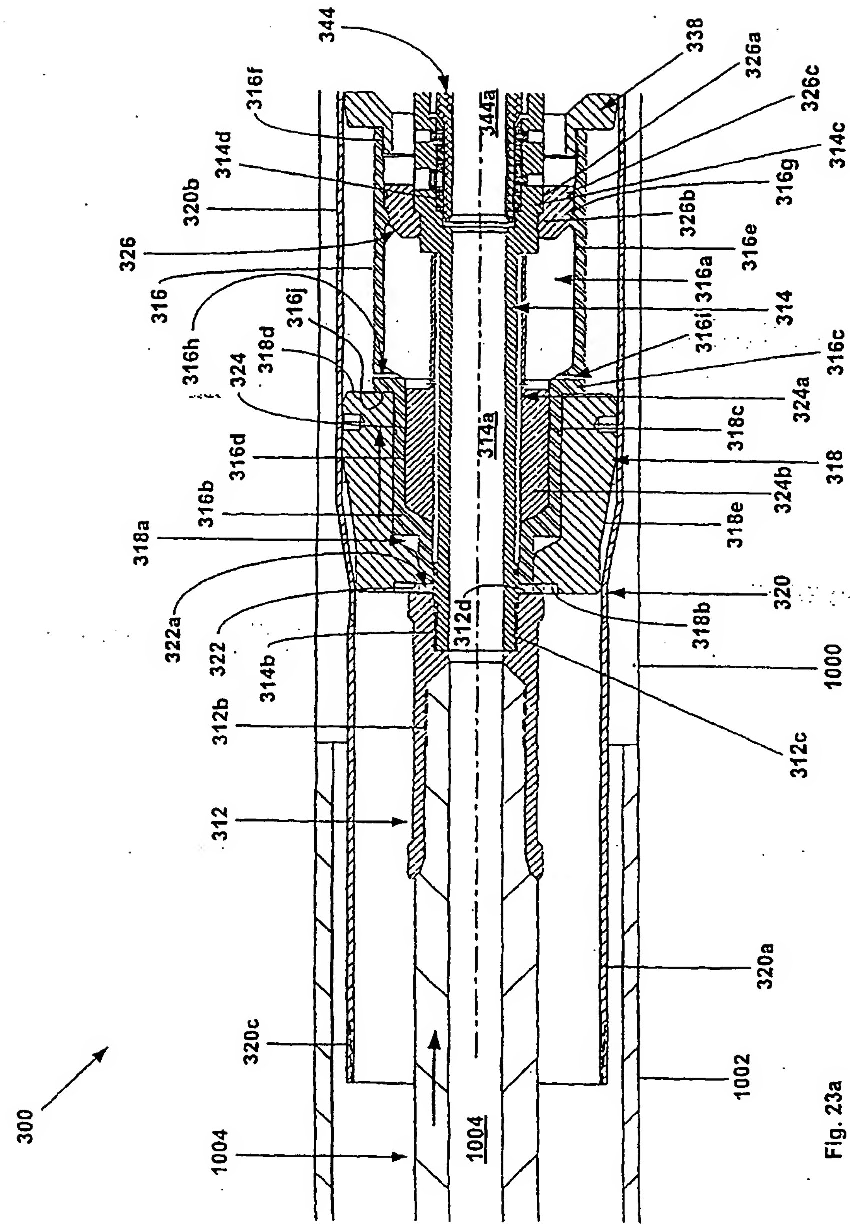
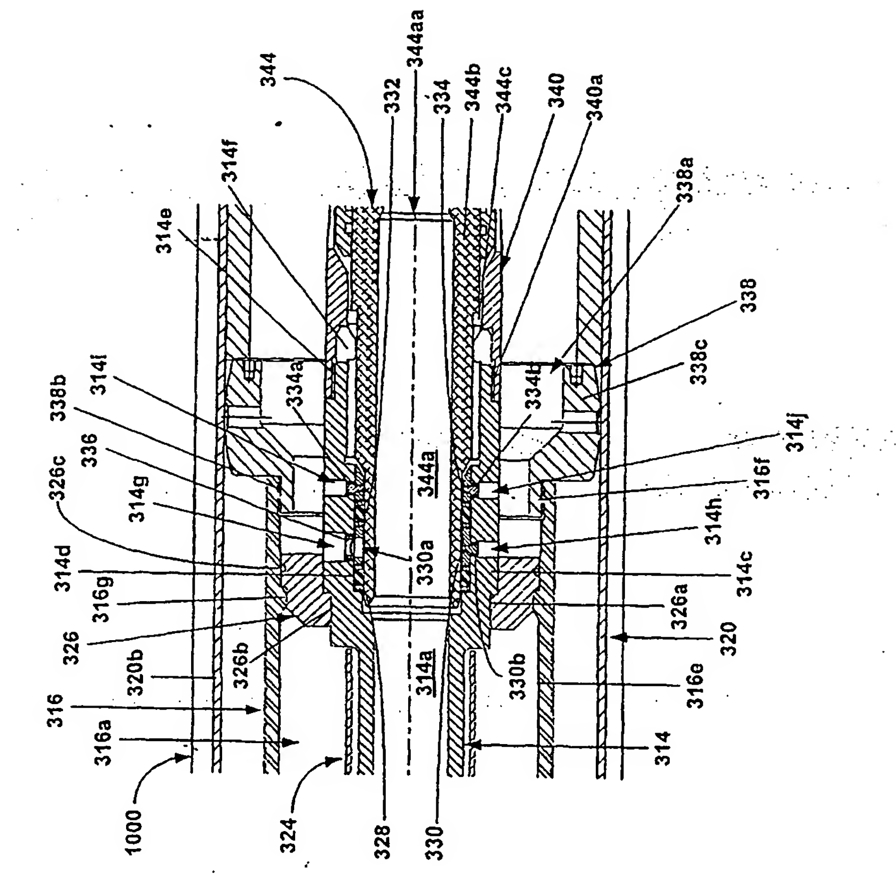

344
344a
338
326a
326c
314c
316g
326b
316e
316a
314
316i
316c
324a
318c
318
324b
318e
320
318b
1000
312c
316f
314d
320b
326
316
316h
316j
318d
324
314a
316d
316b
318a
322a
322
312d
314b
312b
312
320a
320c
1004
1004
1002
300

Fig. 23a



300
1000
316a
316
320b
326
316g
314d
326c
314g
336
338b
314i
334a
314e
314f
344
332
344aa
334
344b
344c
340
340a
338a
338
338c
334b
344a
314j
316f
314h
330a
314c
326a
320
316e
314
326b
324
328
314a
330
330b

Fig. 23b

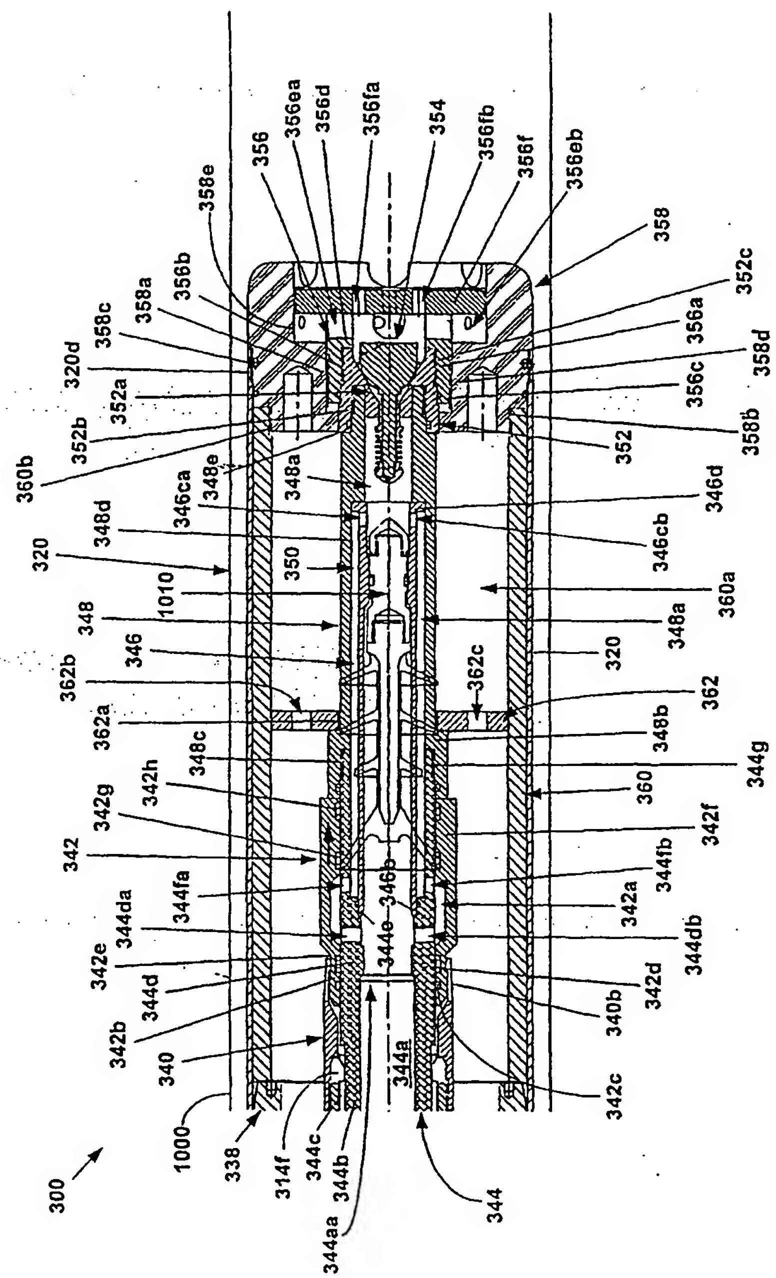

300
1000
338
314f
344c
344b
344aa
344
340
342b
344d
342e
344da
344fa
342
342g
342h
348c
362a
362b
346
348
1010
320
350
348d
346ca
348e
348a
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
348a
320
362c
362
348b
344g
360
342f
344fb
342a
344db
342d
340b
342c
344e
346b
344a

Fig. 23c

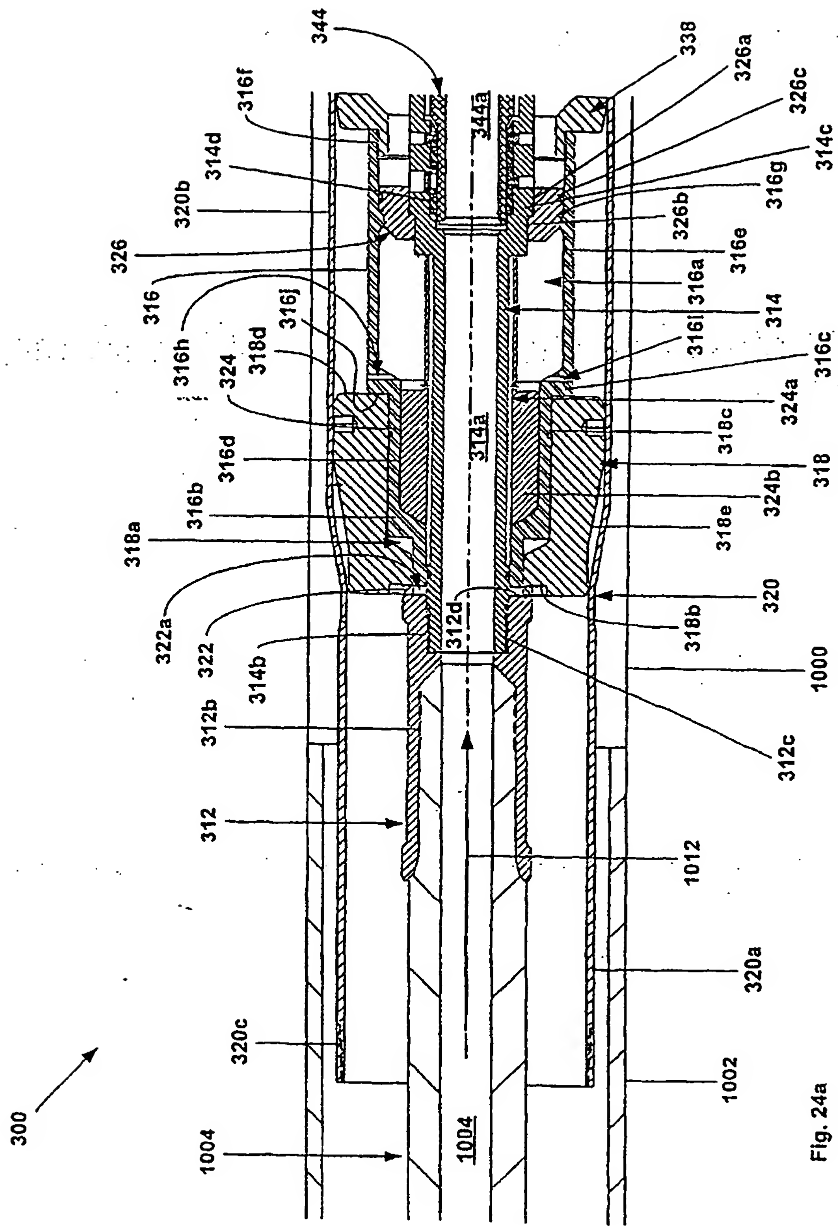

344
338
326a
326c
314c
316g
326b
316e
316a
314
316i
316c
324a
318c
318
324b
318e
320
318b
1000
312c
1012
320a
1002
316f
314d
320b
326
316
316h
316j
318d
324
316d
316b
318a
322a
322
314b
312d
312b
312
320c
300
1004
344a
314a

Fig. 24a

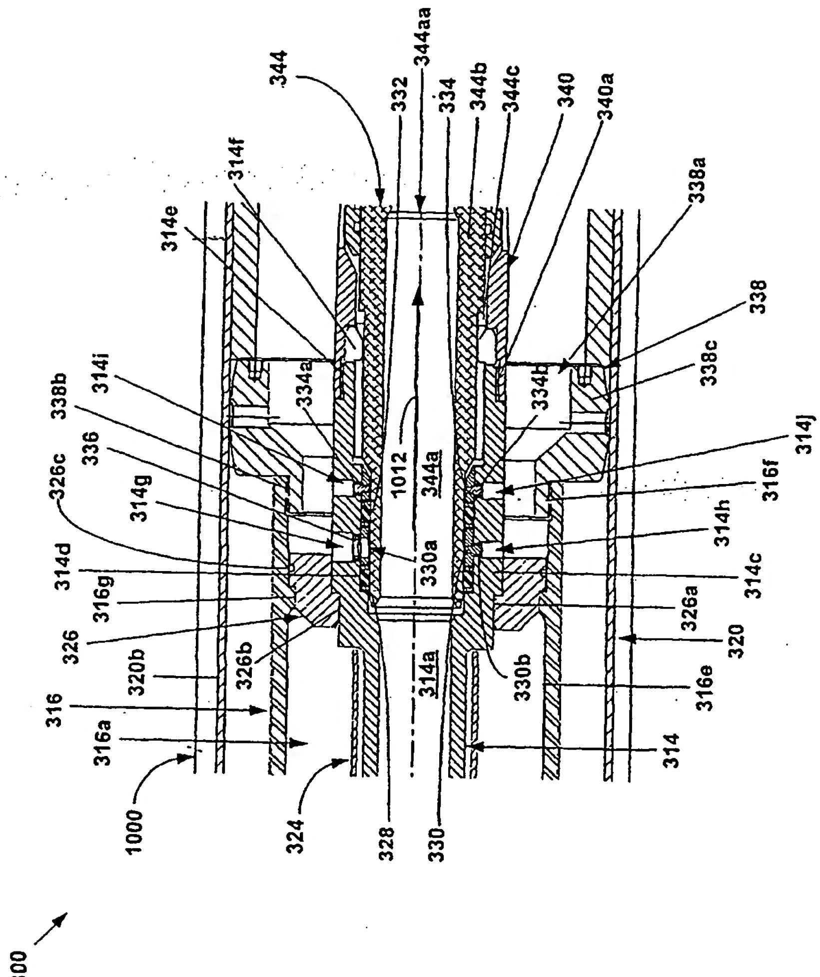

300
1000
316a
316
320b
326
316g
314d
326c
314g
336
338b
314i
334a
314e
314f
344
332
344aa
334
344b
344c
340
340a
338a
338
338c
314j
316f
314h
314c
326a
320
316e
314
330b
330a
344a
1012
334b
314a
326b
324
328
330

Fig. 24b

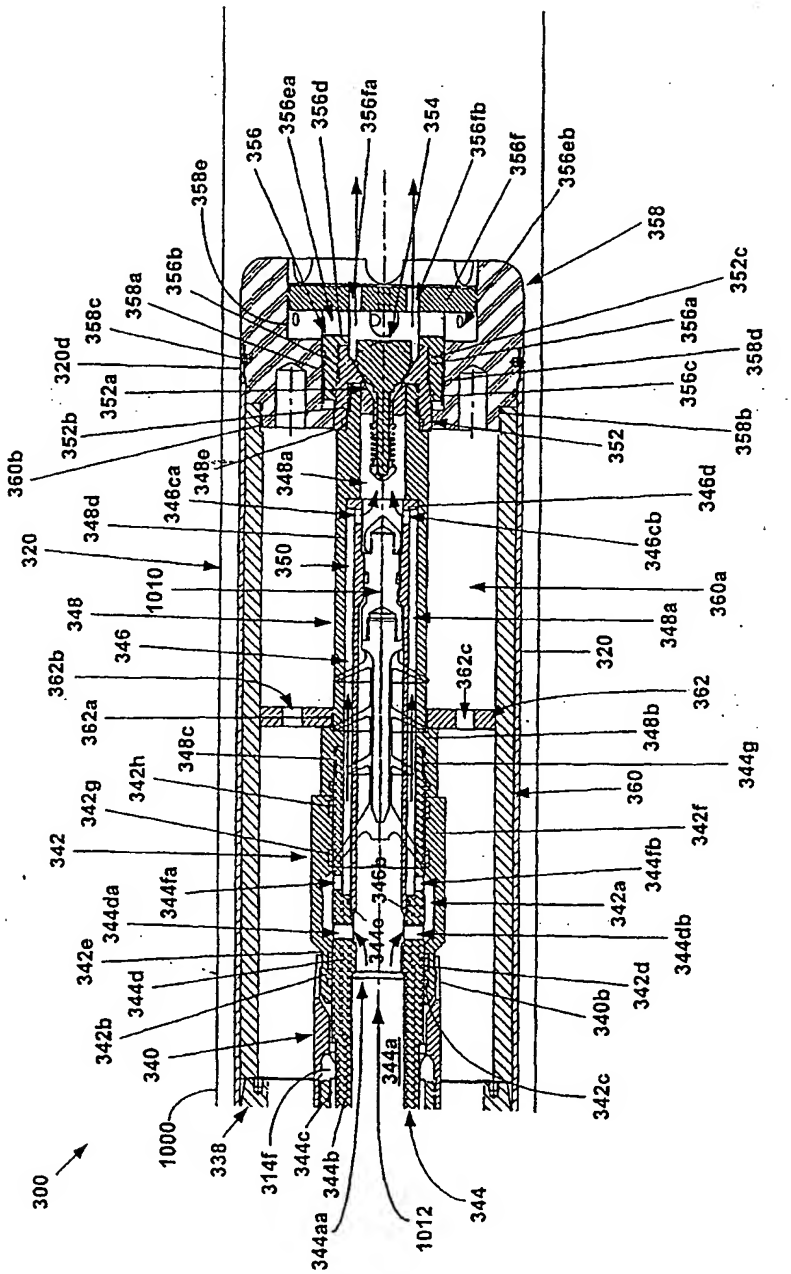

300
1000
338
314f
344c
344b
344aa
1012
344
344a
340
342b
344d
342e
344da
344fa
342
342g
342h
348c
362a
362b
346
348
1010
350
348d
346ca
348e
348a
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
348a
320
320
362c
362
348b
344g
360
342f
344fb
342a
344db
340b
342d
342c
346b
344e

Fig. 24c

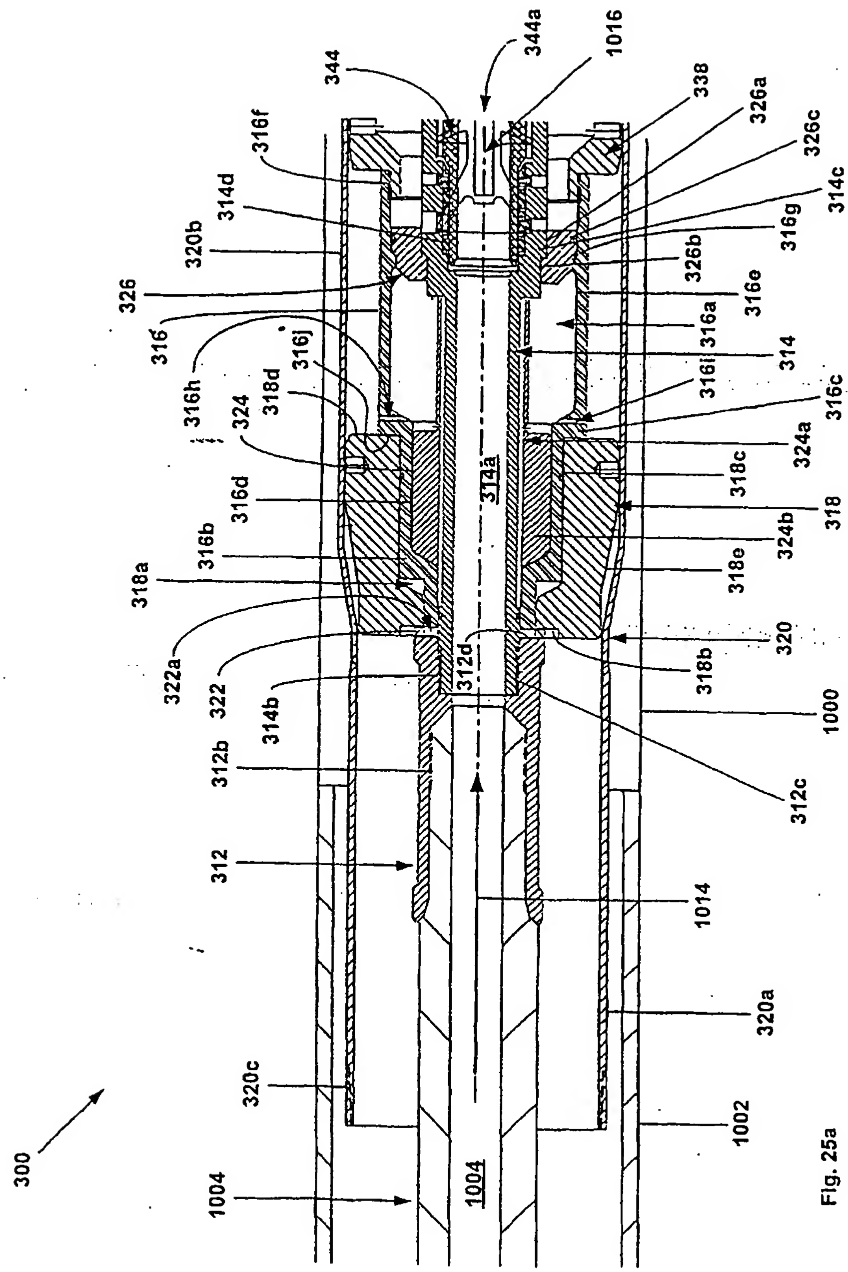

344
344a
1016
338
326a
326c
314c
316f
314d
320b
316g
326b
326
316e
316
316a
316h
316j
314
316i
318d
324
316c
324a
314a
318c
316d
318
316b
324b
318e
318a
320
312d
318b
322a
322
314b
1000
312b
312c
312
1014
320a
320c
1002
300
1004
1004

Fig. 25a

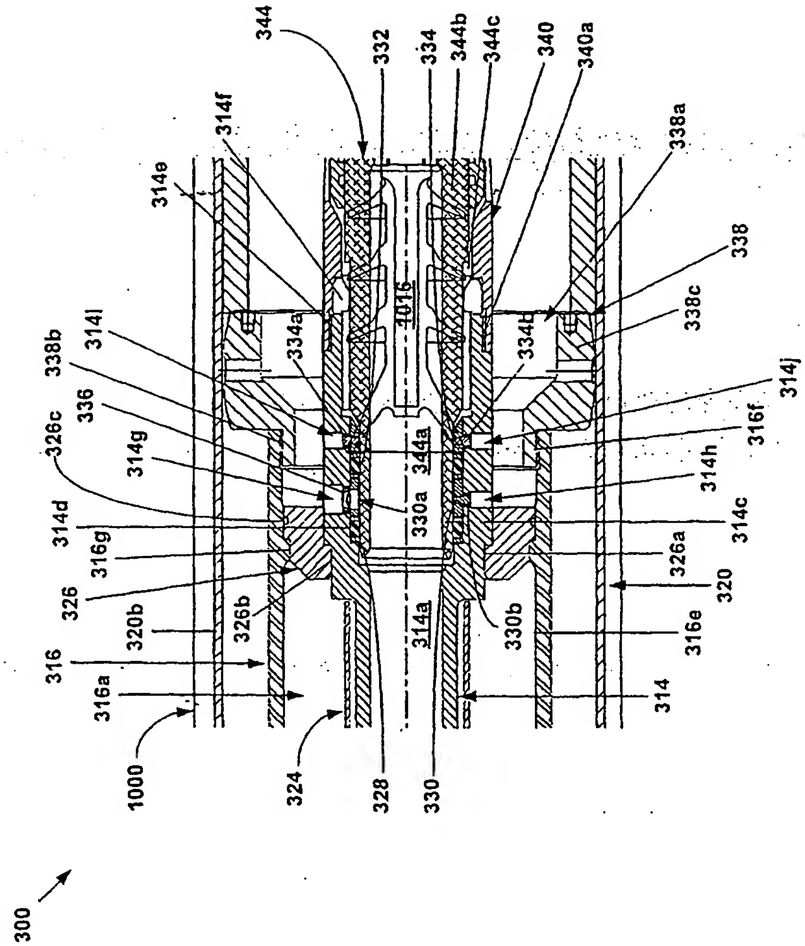

300
1000
316a
316
320b
326b
326
316g
314d
326c
314g
336
338b
314l
334a
314e
314f
344
332
334
344b
344c
340
340a
338a
338
338c
334b
314j
316f
314h
314c
326a
320
316e
314
330b
330a
344a
1016
314a
324
328
330

Fig. 25b

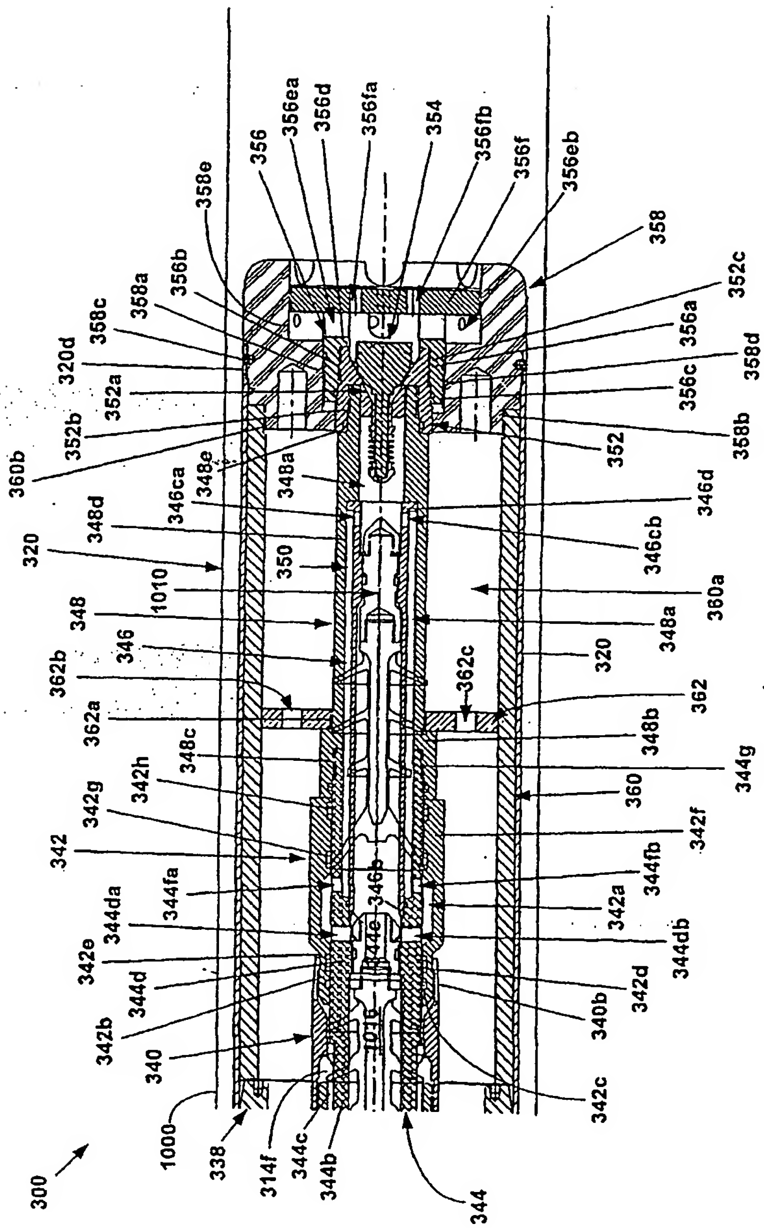

300
1000
338
314f
344c
344b
344
340
342b
344d
342e
344da
344fa
342
342g
342h
348c
362a
362b
346
348
1010
350
348d
346ca
348e
348a
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
348a
320
362c
362
348b
344g
360
342f
344fb
342a
344db
342d
340b
342c
346b
344e
1016
320

Fig. 25c

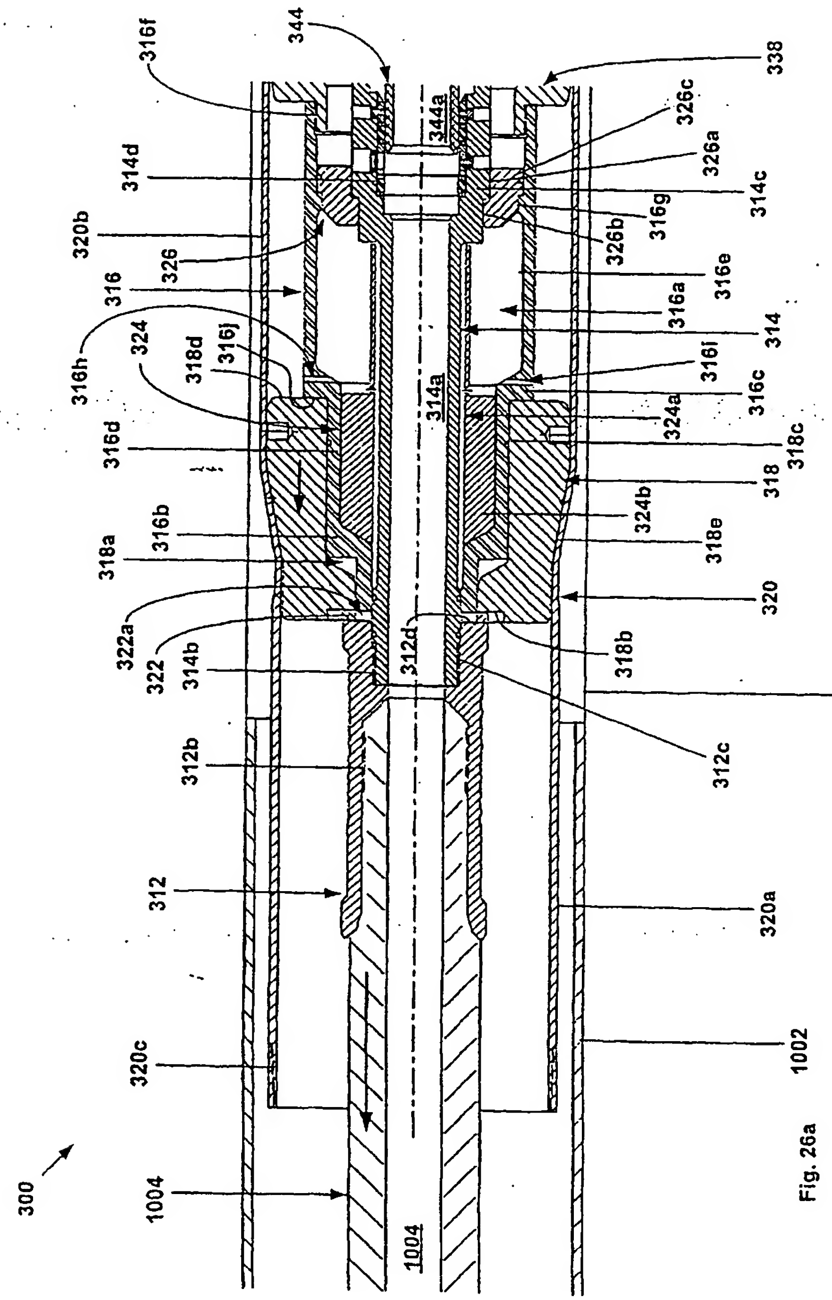

344
316f
338
344a
326c
326a
314d
314c
316g
326b
320b
326
316e
316
316a
314
324
316h
318d
316j
316i
316c
314a
324a
316d
318c
318
324b
316b
318e
318a
320
322a
322
312d
318b
314b
1000
312b
312c
312
320a
320c
1002
300
1004
1004

Fig. 26a

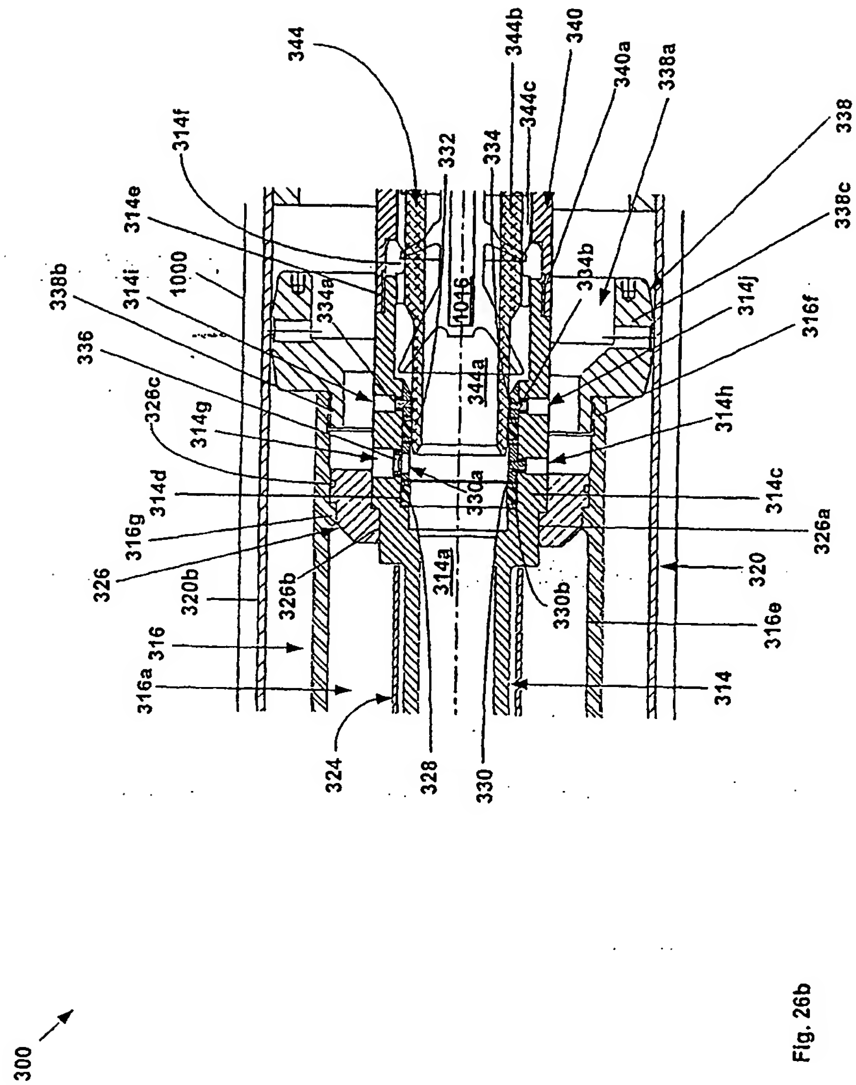

344
344b
340
340a
338a
338
338c
314j
316f
314h
314c
326a
320
316e
314
330
330b
328
324
316a
316
320b
326b
326
316g
314d
326c
314g
336
338b
314i
1000
314e
314f
332
334
344c
334a
1016
344a
334b
330a
314a
300

Fig. 26b

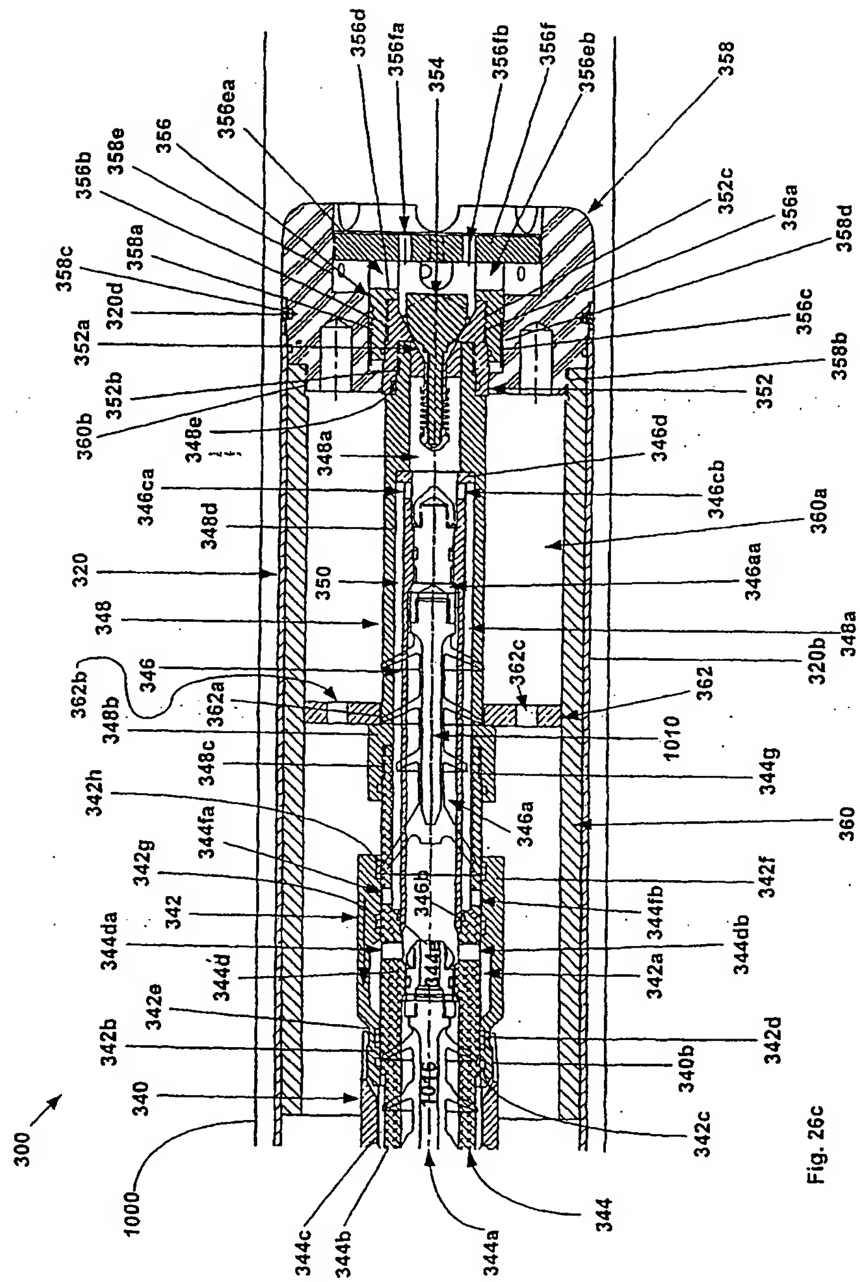

300
1000
340
342b
342e
344d
344da
342
342g
344fa
342h
348c
348b
362b
346
348
320
350
348d
346ca
348a
348e
360b
352b
352a
320d
358c
358a
356b
358e
356
356ea
356d
356fa
354
356fb
356f
356eb
358
352c
356a
358d
356c
358b
352
346d
346cb
360a
346aa
348a
320b
362c
362a
362
1010
344g
346a
360
342f
346b
344fb
344db
344e
342a
342d
340b
342c
1016
344c
344b
344a
344

Fig. 26c

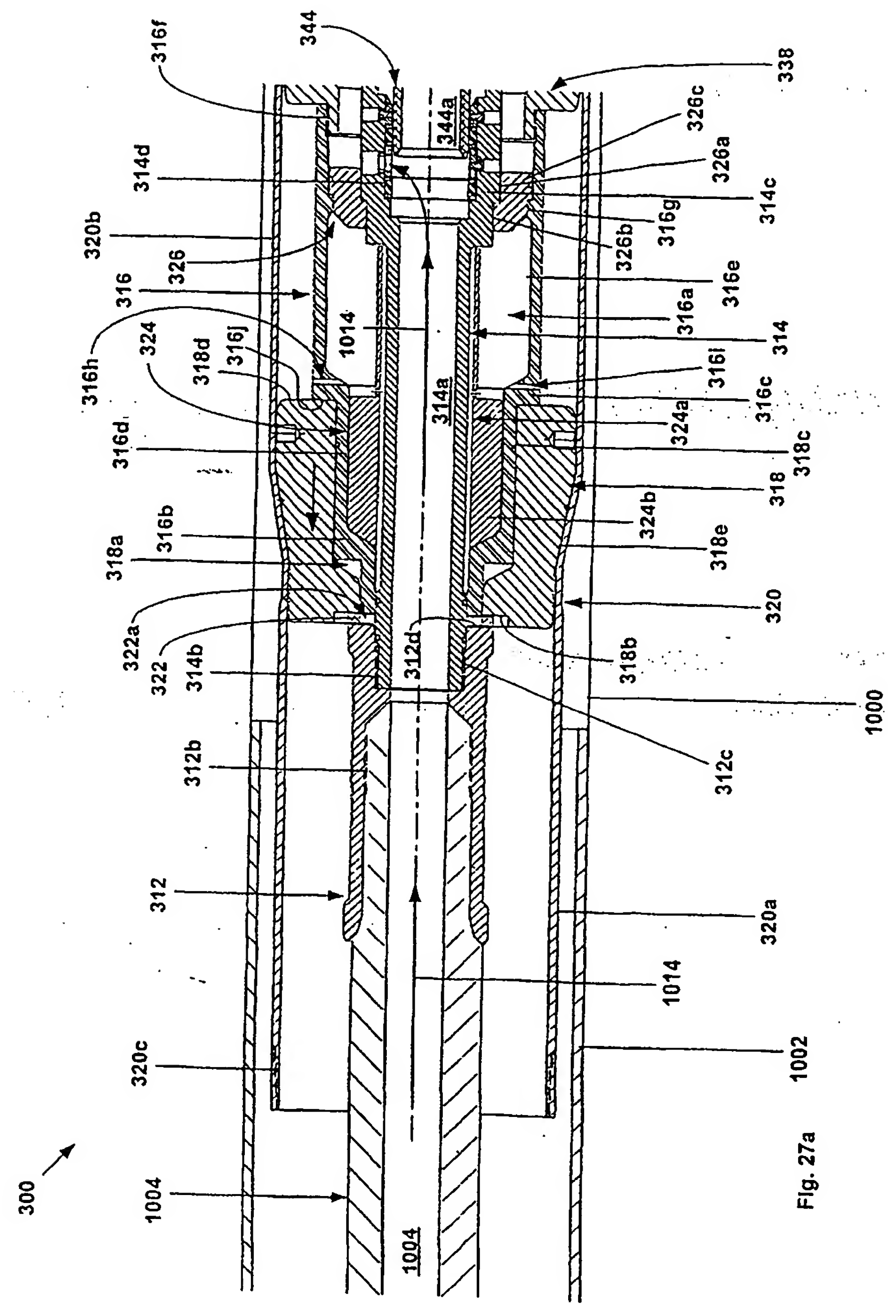
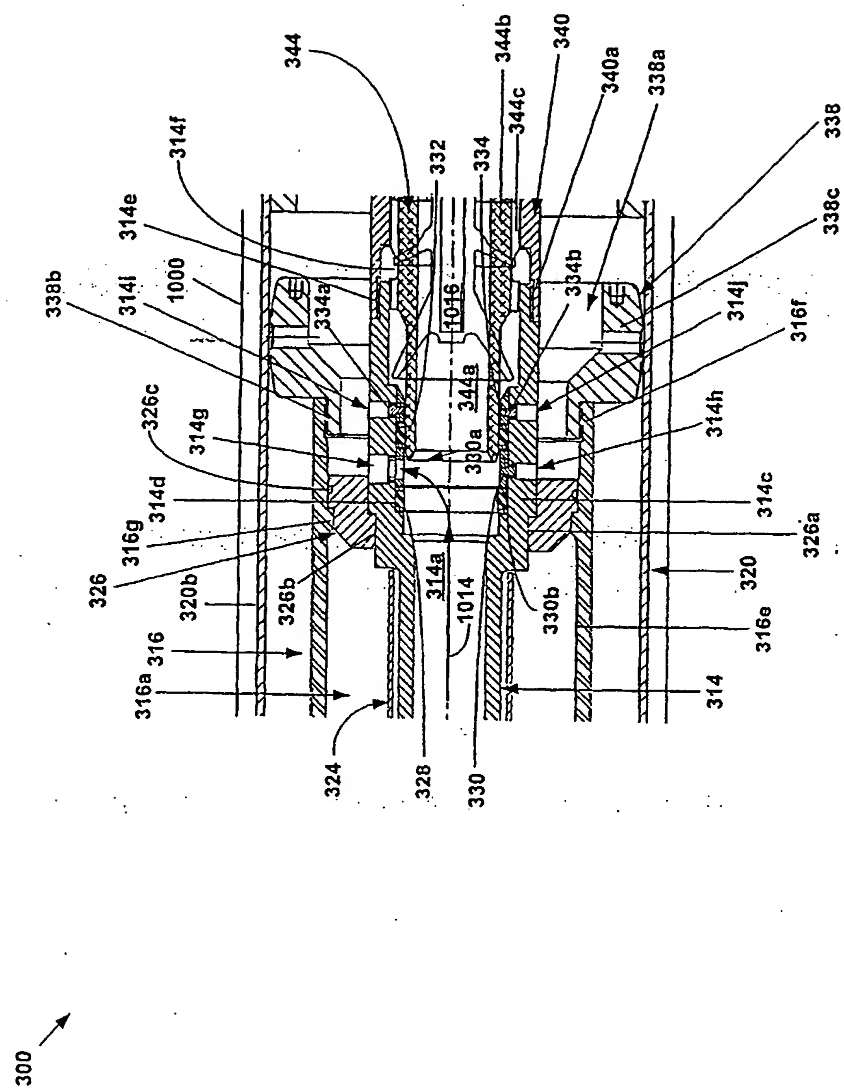

300
316f
344
338
344a
326c
326a
314d
314c
316g
326b
320b
326
316
316e
316a
1014
314
316h
324
318d
316j
316i
316c
314a
324a
316d
318c
318
324b
316b
318a
318e
320
322a
322
312d
318b
314b
1000
312b
312c
312
320a
1014
320c
1002
1004
1004

Fig. 27a



344
344b
340
340a
338a
338
338c
314f
332
334
344c
314e
1016
334b
314j
316f
338b
314i
1000
334a
344a
326c
314g
330a
314h
314d
314c
316g
326a
326
314a
320b
326b
1014
330b
320
316
316e
316a
314
324
328
330
300

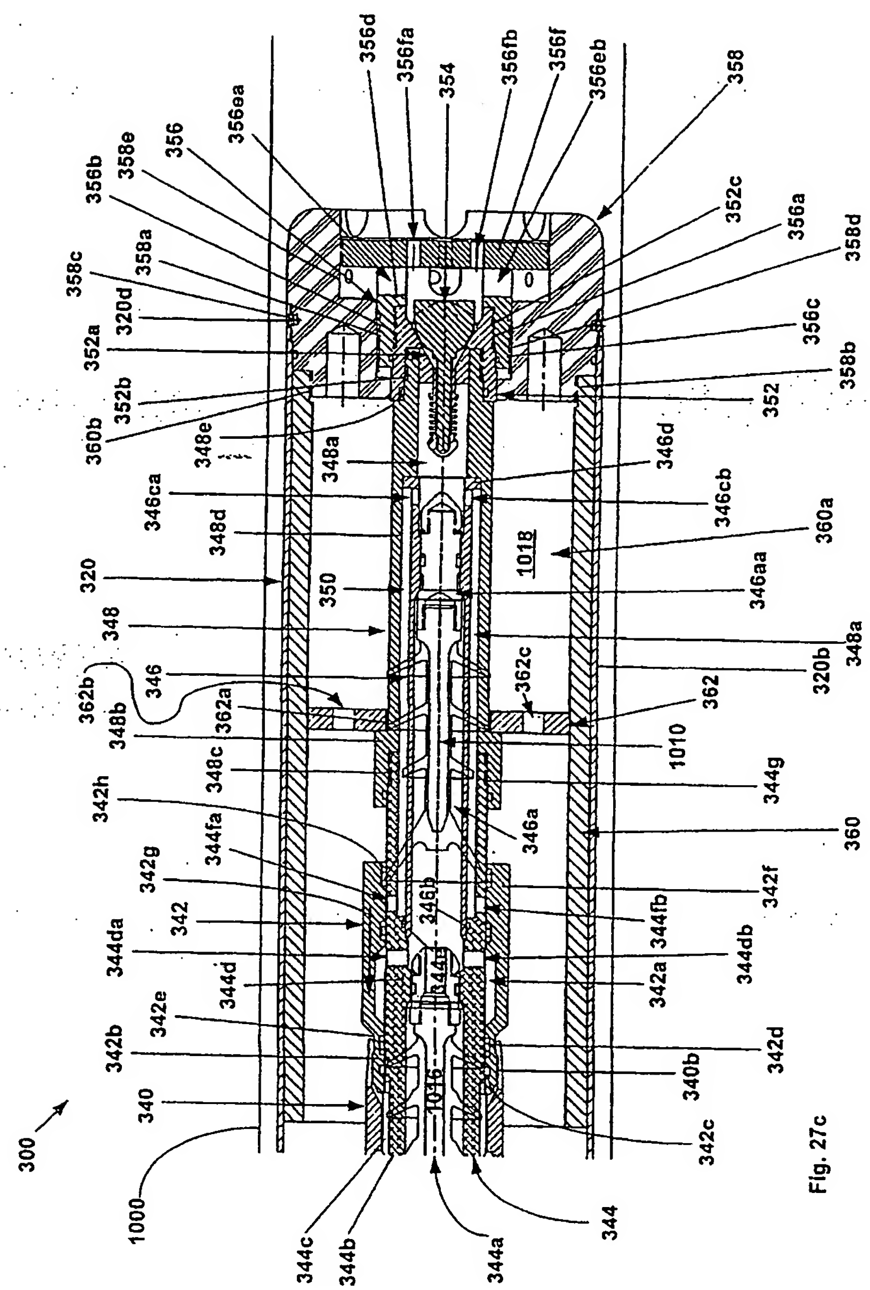


Fig. 27c

80/100

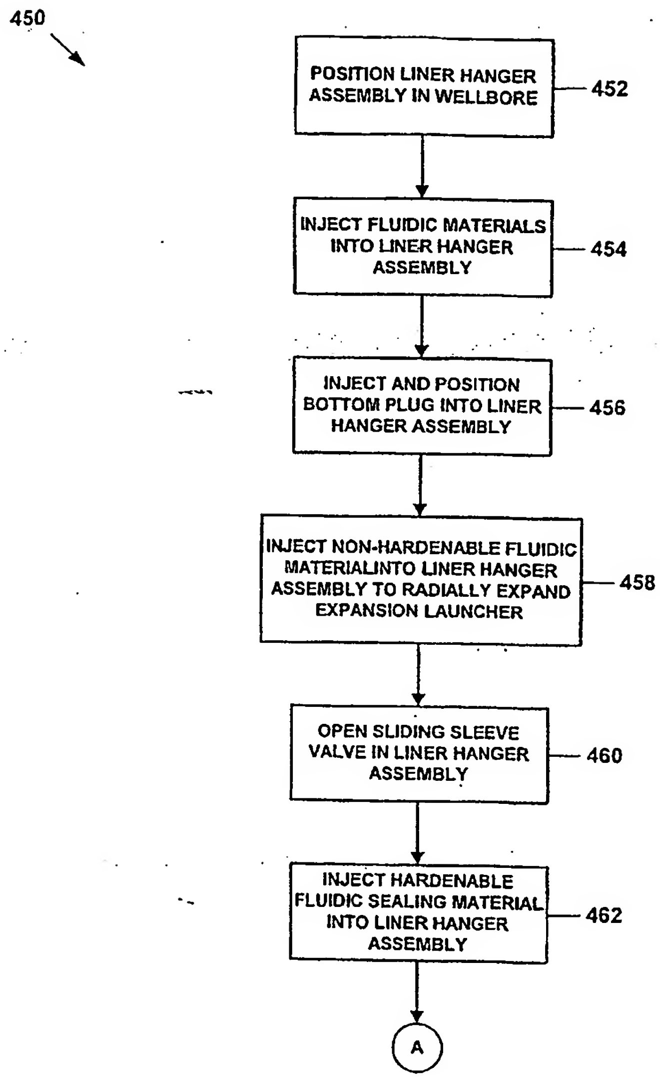

450
POSITION LINER HANGER ASSEMBLY IN WELLBORE
452
INJECT FLUIDIC MATERIALS INTO LINER HANGER ASSEMBLY
454
INJECT AND POSITION BOTTOM PLUG INTO LINER HANGER ASSEMBLY
456
INJECT NON-HARDENABLE FLUIDIC MATERIALINTO LINER HANGER ASSEMBLY TO RADIALLY EXPAND EXPANSION LAUNCHER
458
OPEN SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
460
INJECT HARDENABLE FLUIDIC SEALING MATERIAL INTO LINER HANGER ASSEMBLY
462
A

Fig. 28a

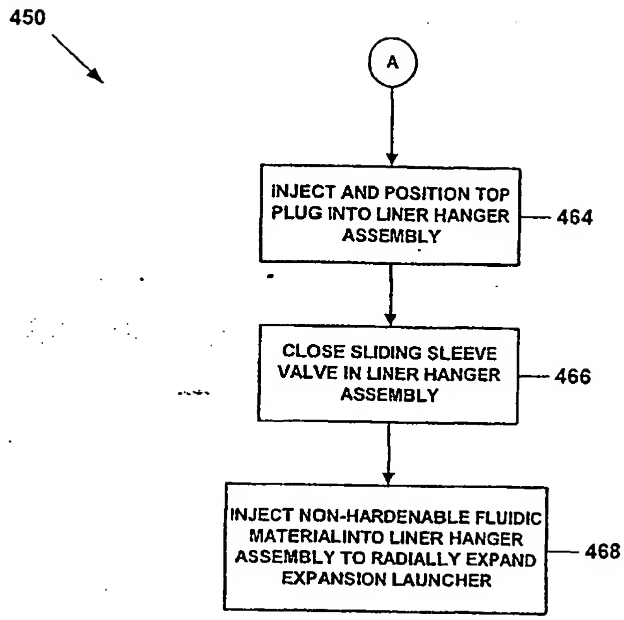
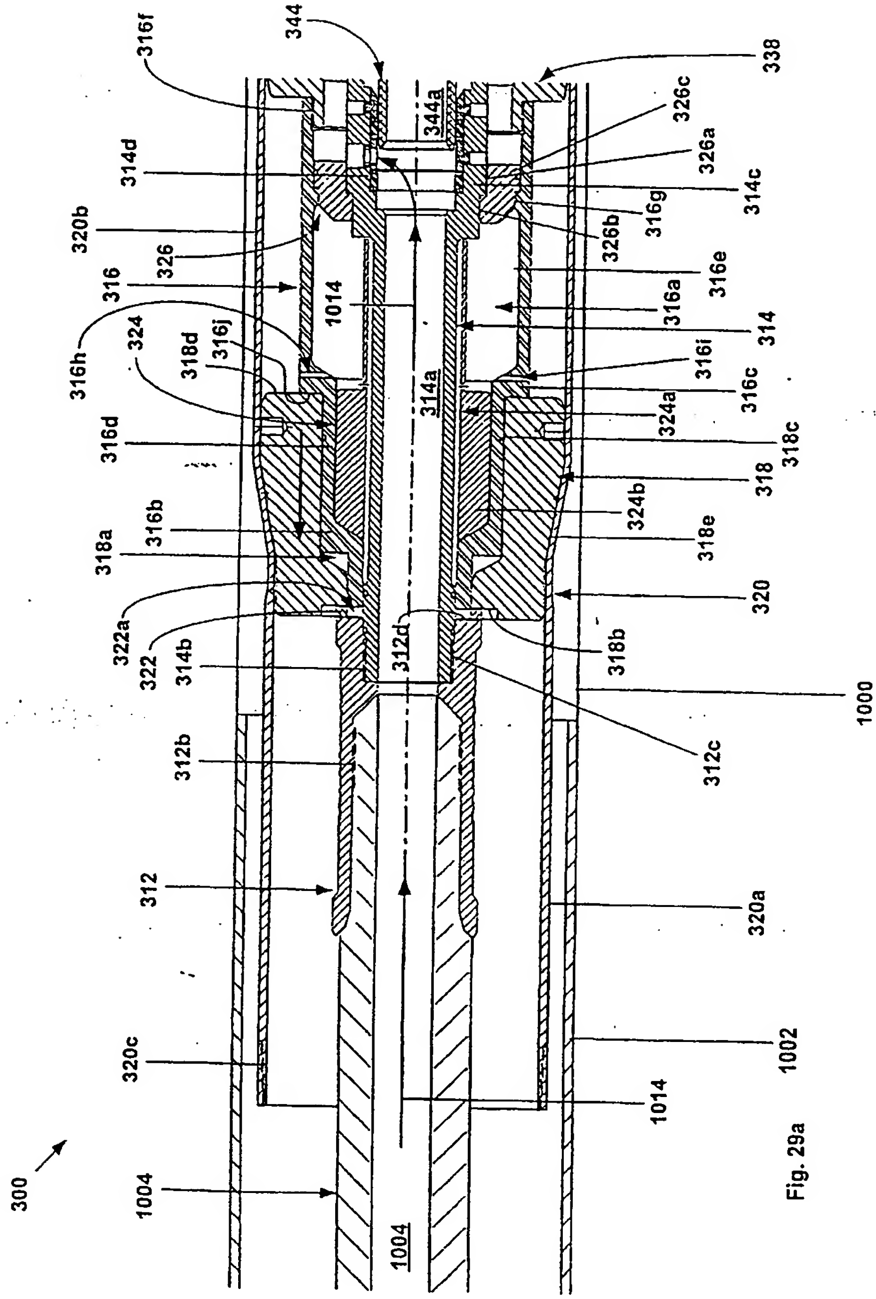
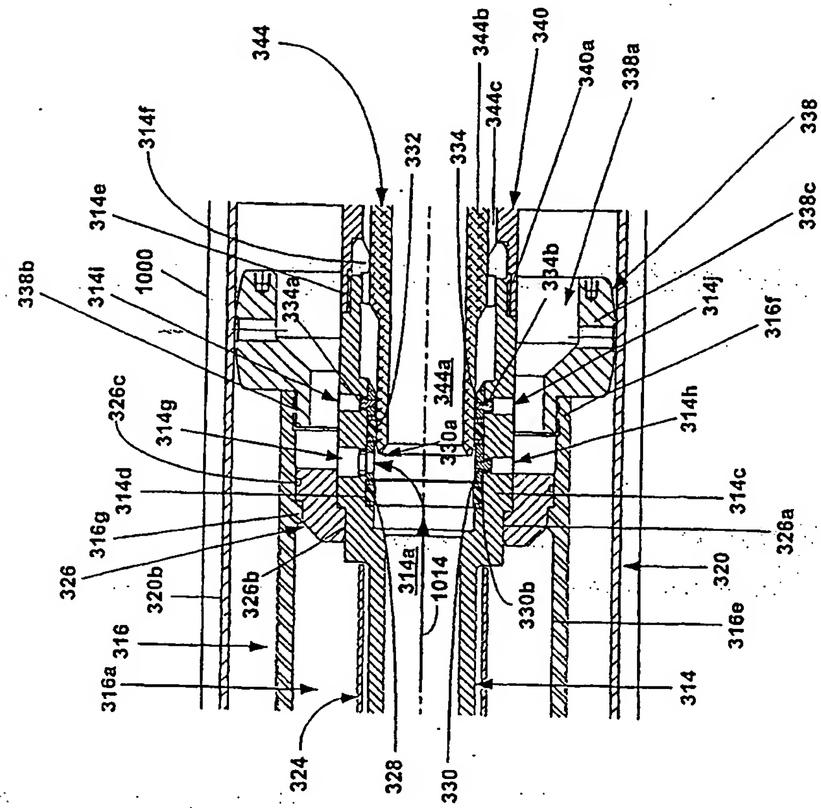

450
A
INJECT AND POSITION TOP PLUG INTO LINER HANGER ASSEMBLY
464
CLOSE SLIDING SLEEVE VALVE IN LINER HANGER ASSEMBLY
466
INJECT NON-HARDENABLE FLUIDIC MATERIALINTO LINER HANGER ASSEMBLY TO RADIALLY EXPAND EXPANSION LAUNCHER
468

Fig. 28b



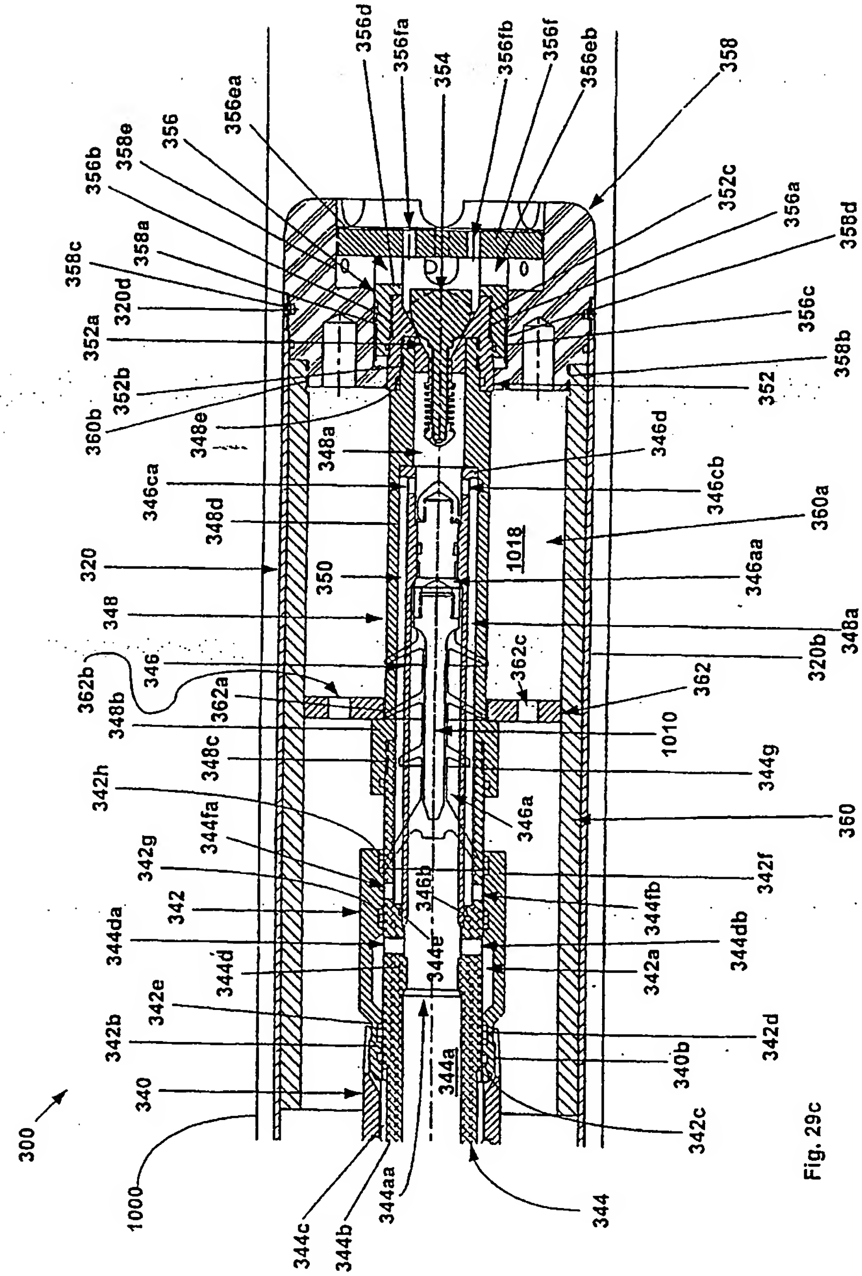
300
316f
344
344a
338
326c
326a
314d
314c
316g
320b
326
326b
316e
316
1014
316a
314
316h
324
318d
316j
316i
316c
314a
324a
316d
318c
318
316b
324b
318a
318e
320
322a
322
312d
318b
314b
1000
312c
312b
312
320a
320c
1002
1014
1004
1004

Fig. 29a


344
314f
314e
332
334
344b
344c
340
340a
338a
338
338c
338b
314i
1000
334a
344a
334b
314j
316f
326c
314g
330a
314h
314d
314c
316g
326a
326
320b
326b
314a
1014
330b
320
316
316e
316a
314
324
328
330

300

Fig. 29b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1000
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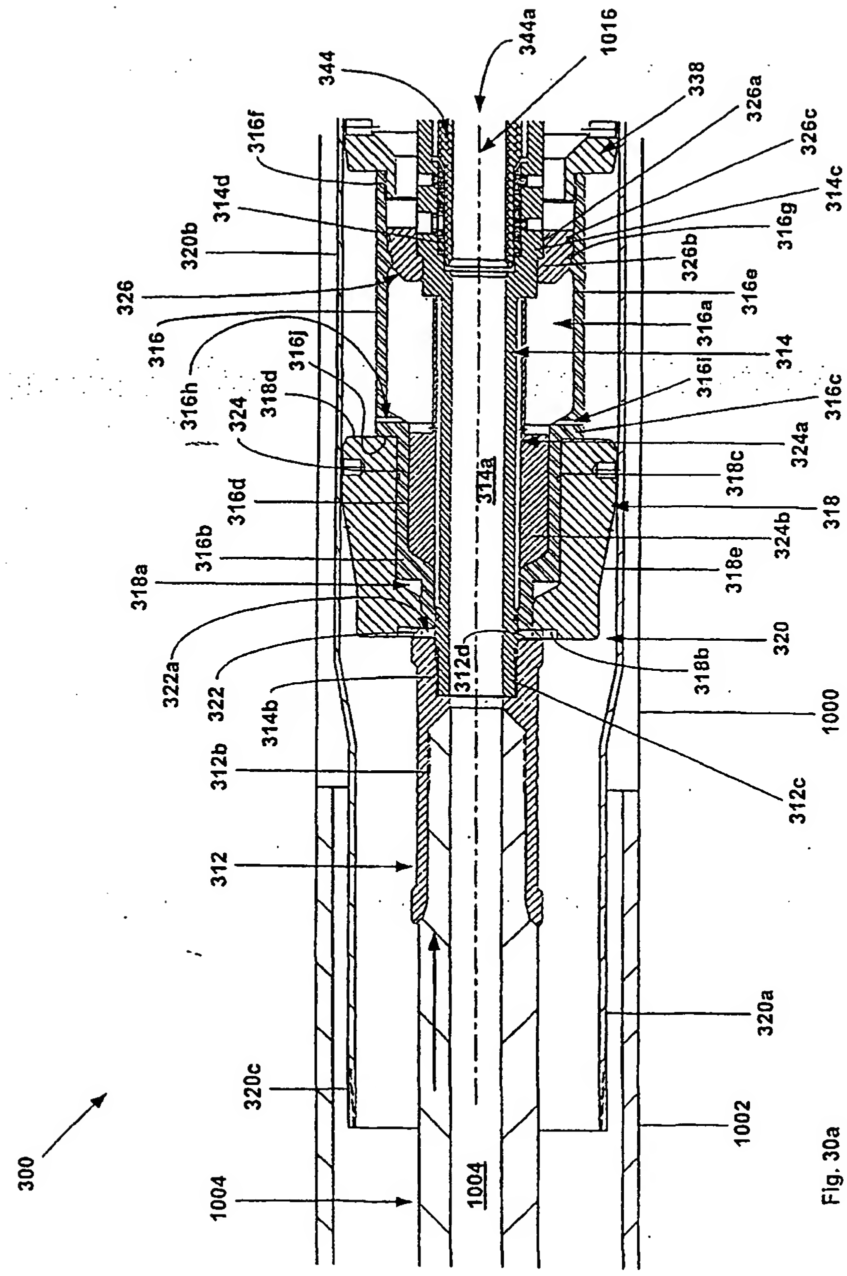
Fig. 29c



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312c
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320b
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316h
316j
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Fig. 30a

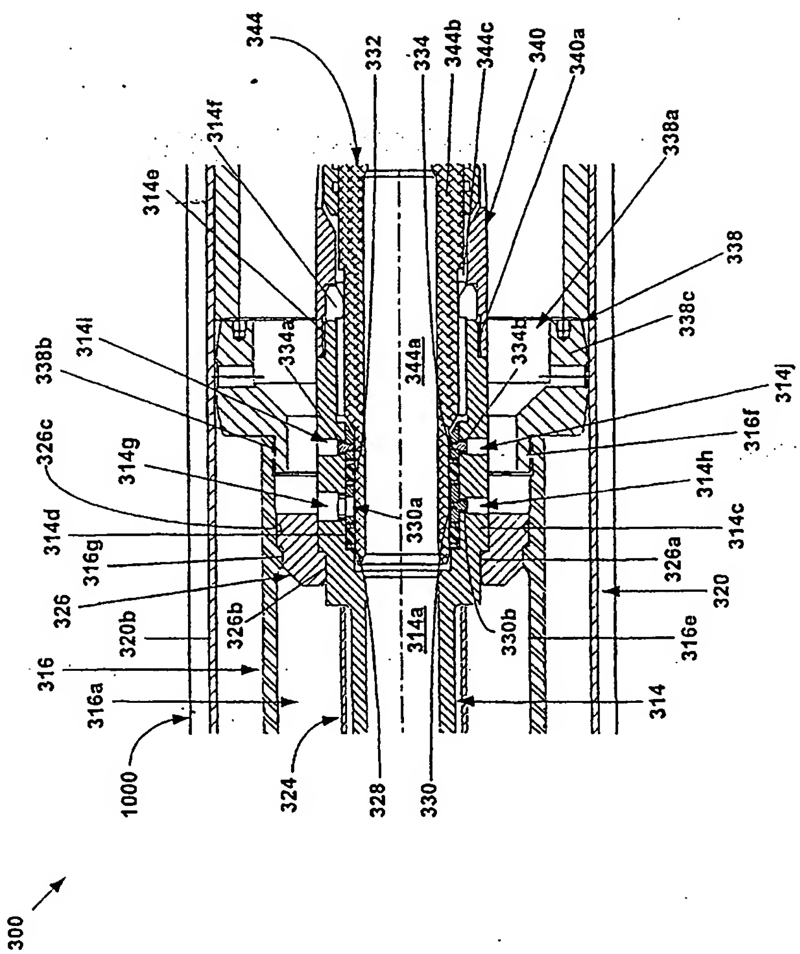
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Fig. 30b

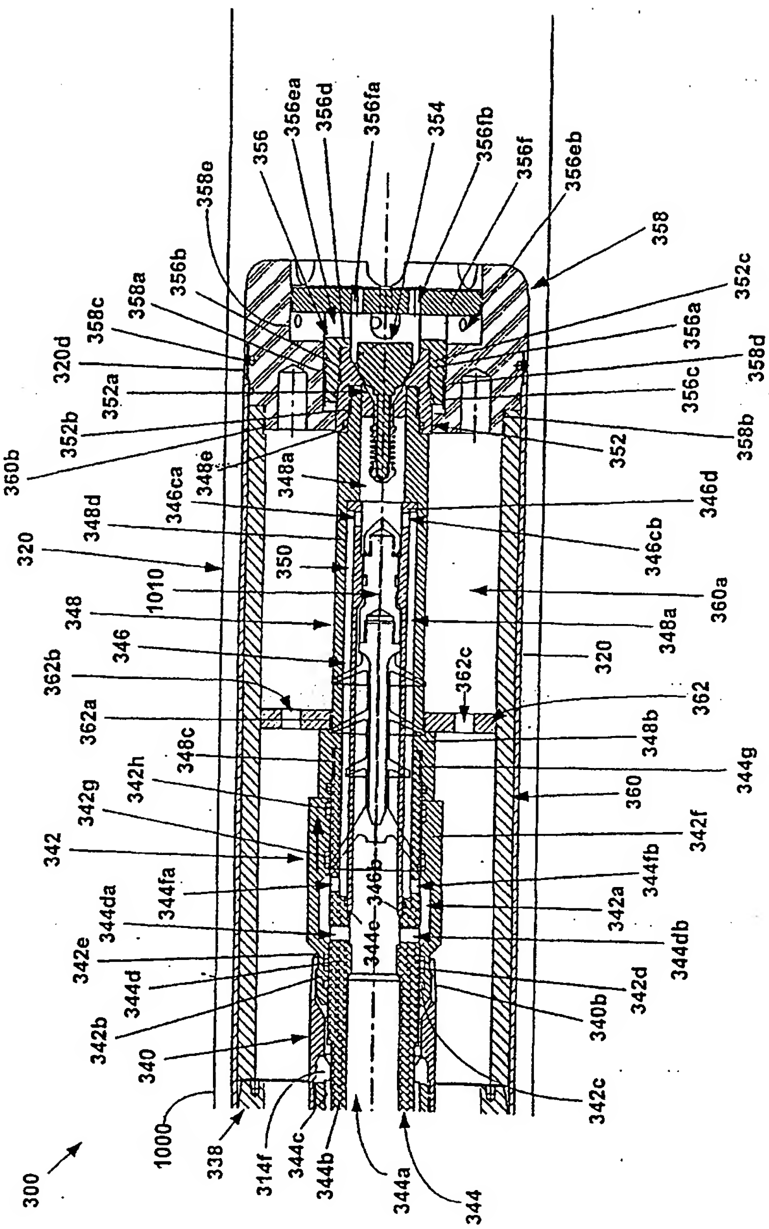
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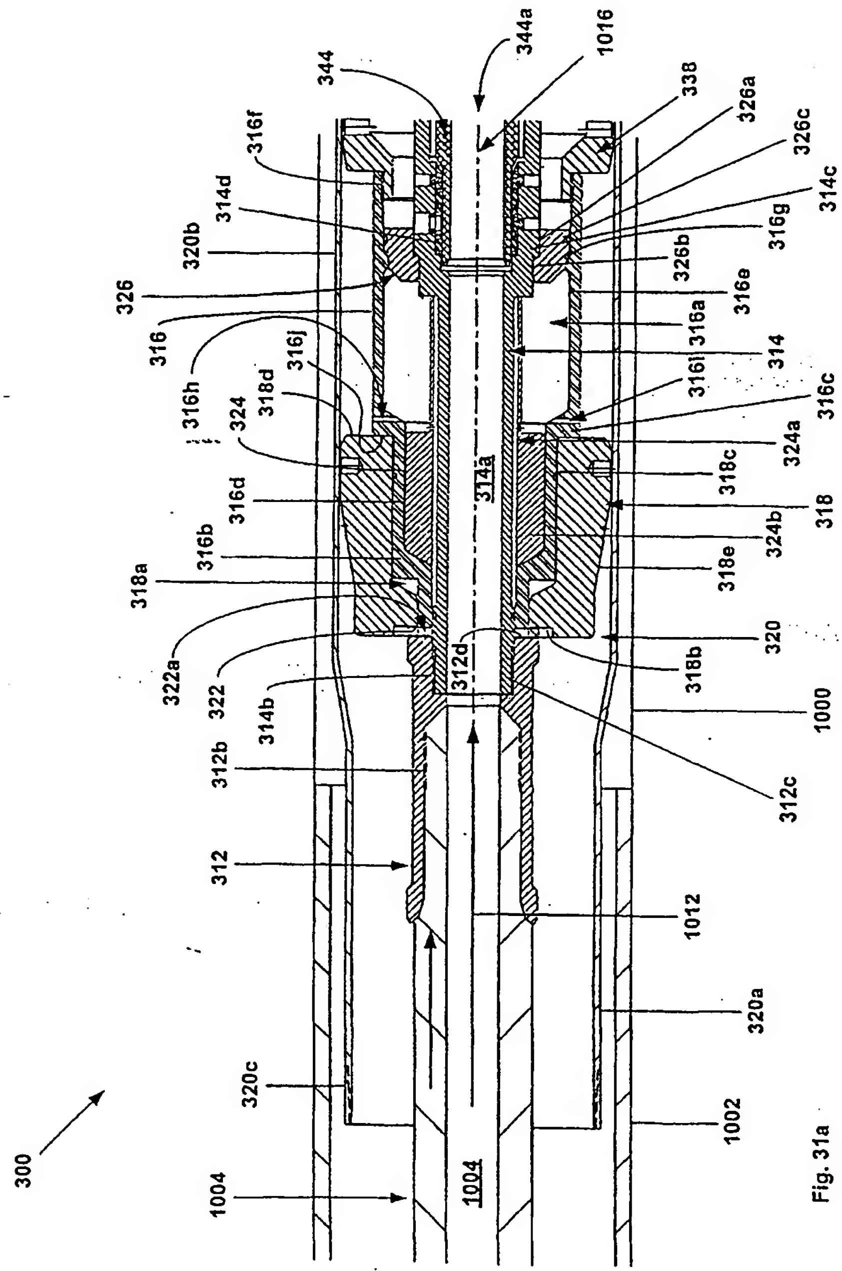
Fig. 30c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1016
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Fig. 31a

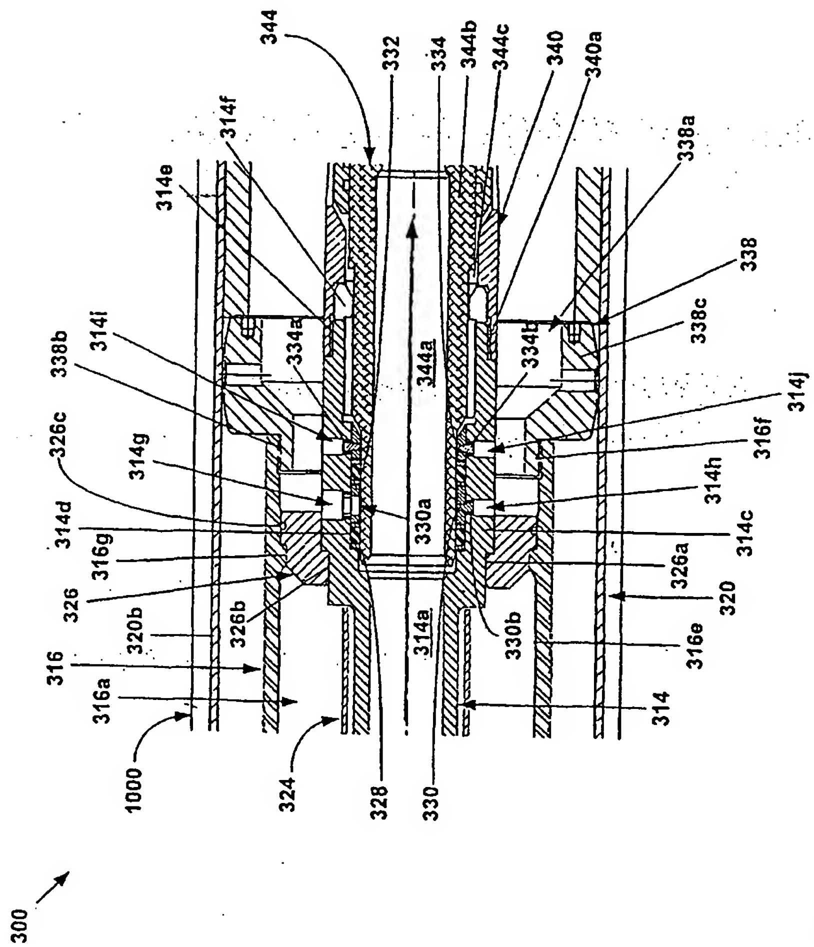
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Fig. 31b

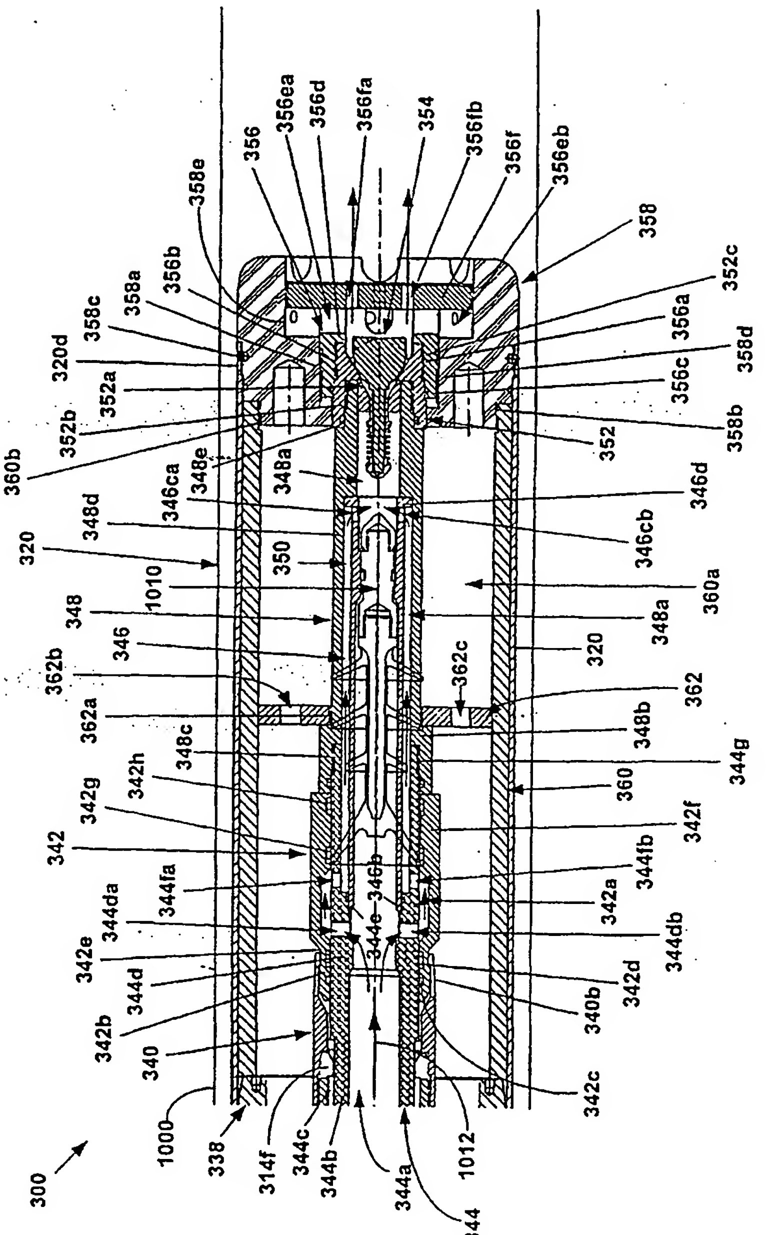
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Fig. 31c

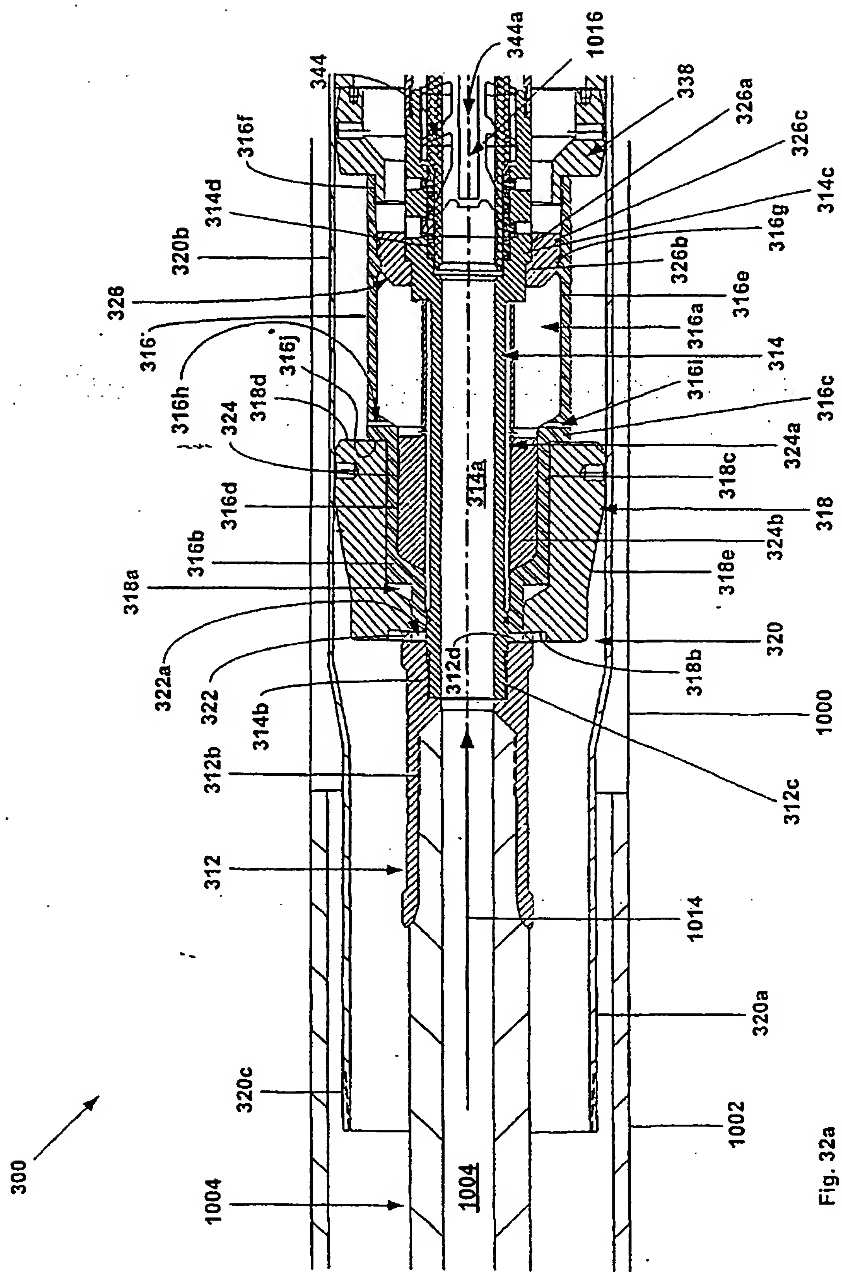
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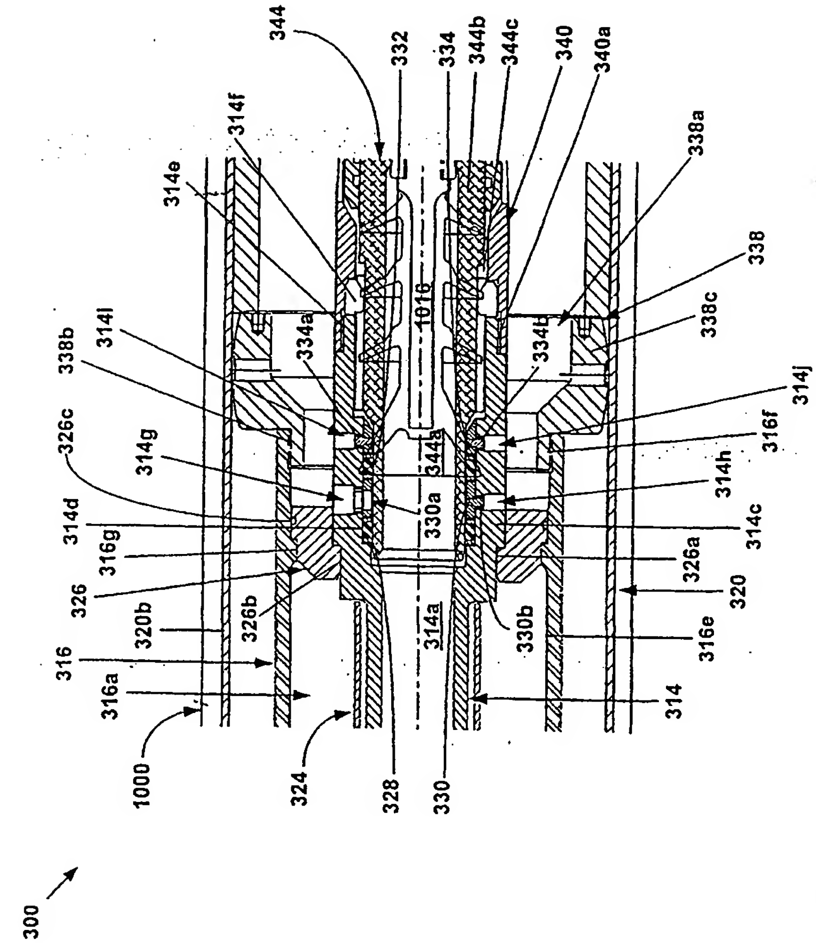
Fig. 32a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330

Fig. 32b

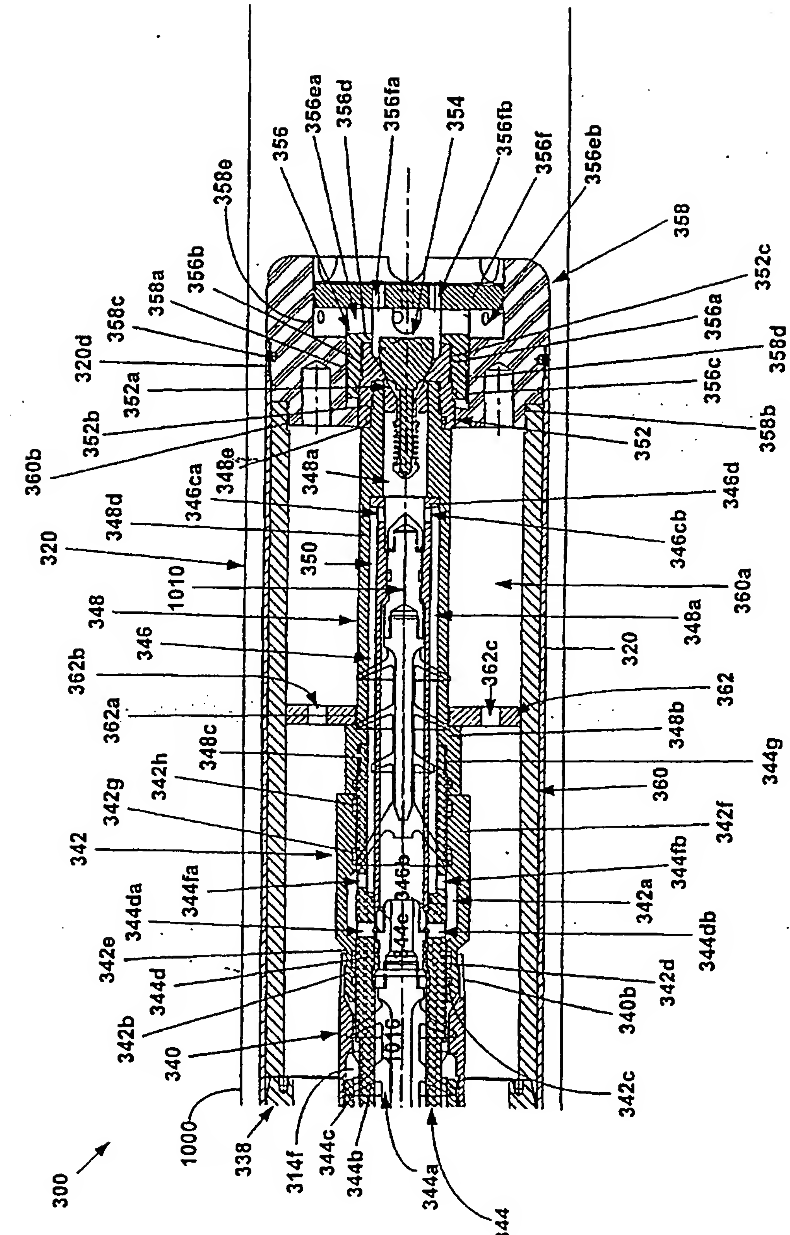
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Fig. 32c

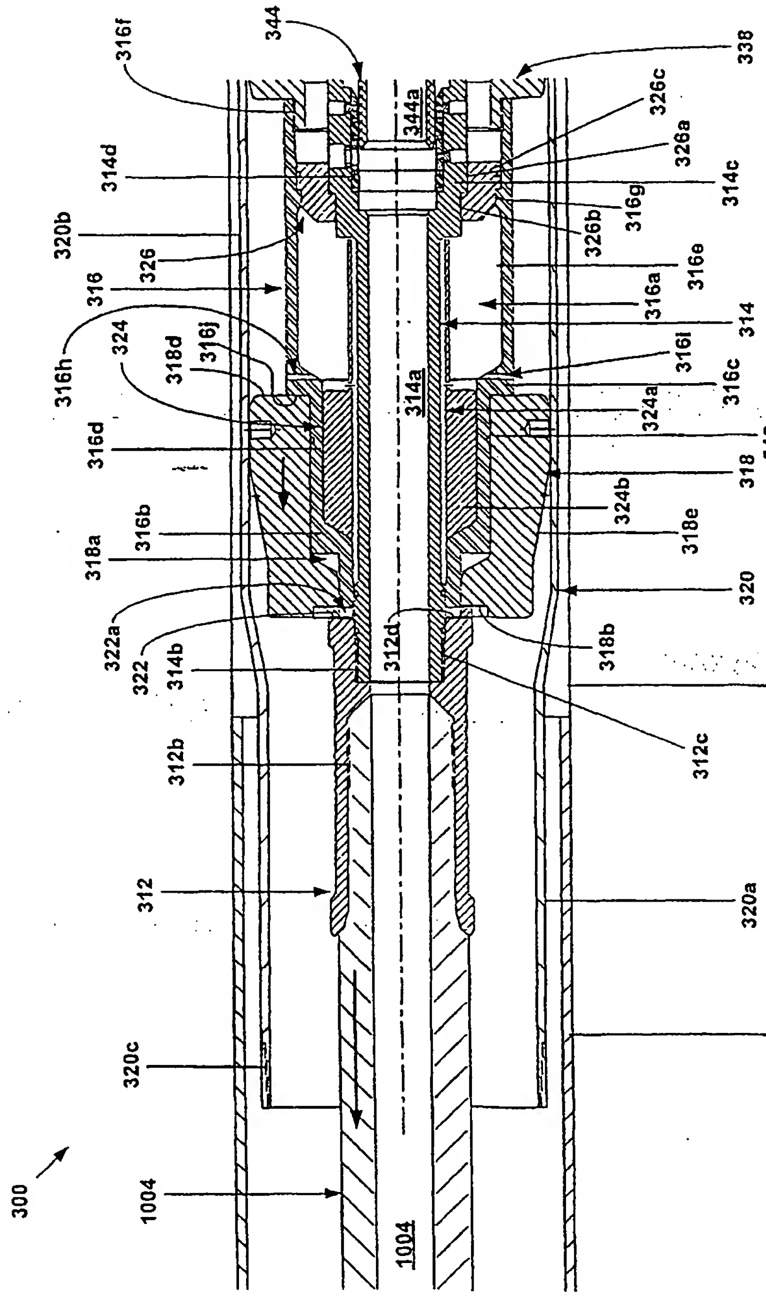
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Fig. 33a

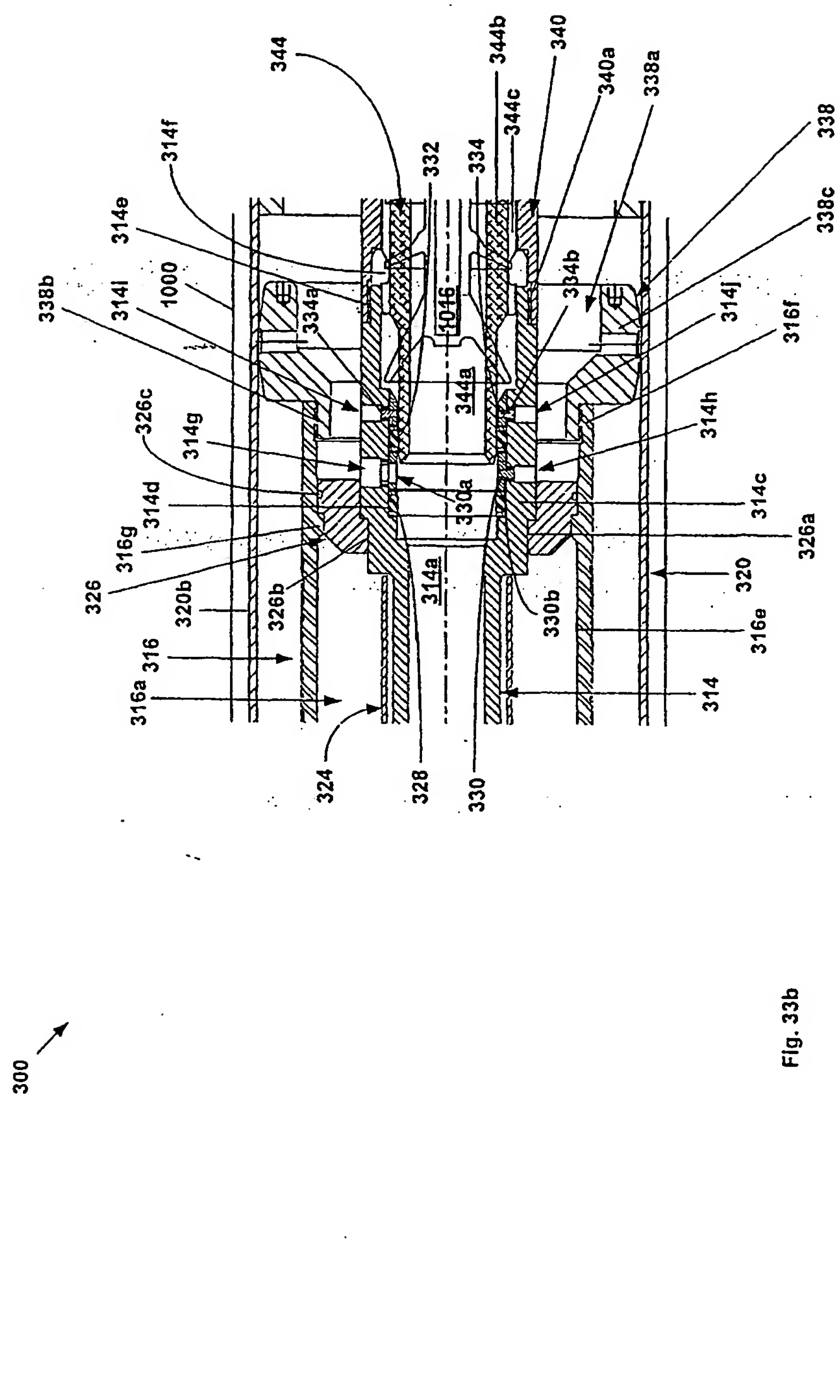
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Fig. 33b

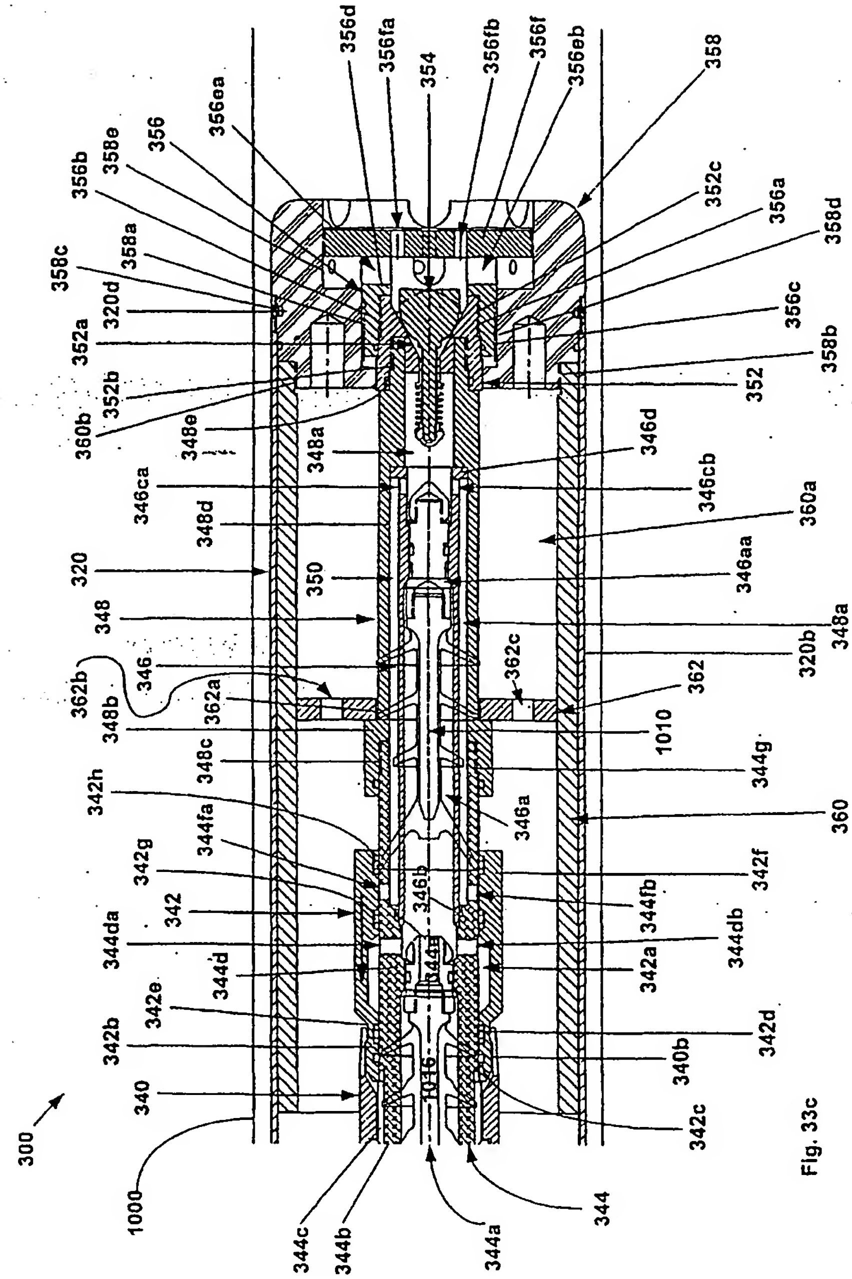
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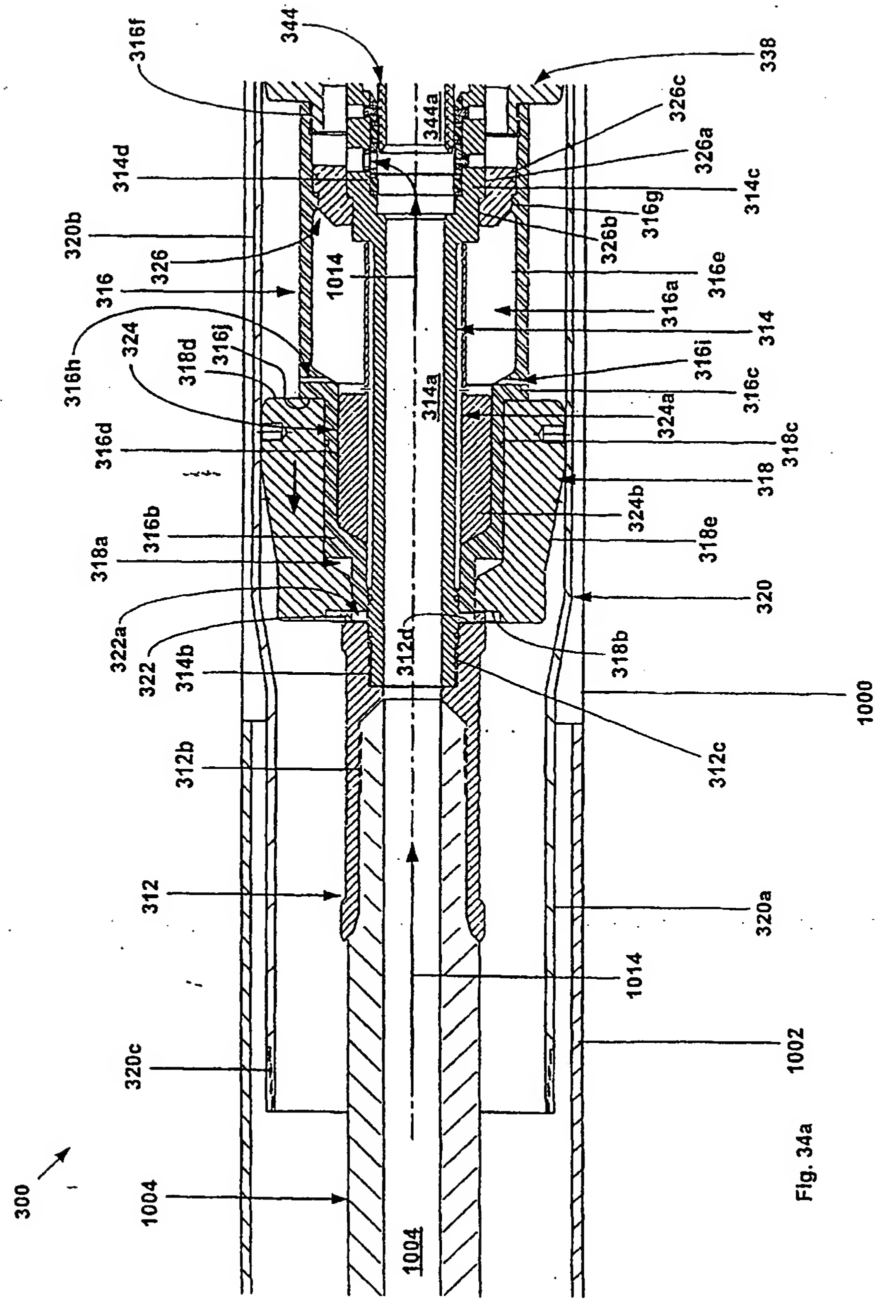
Fig. 33c



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318a
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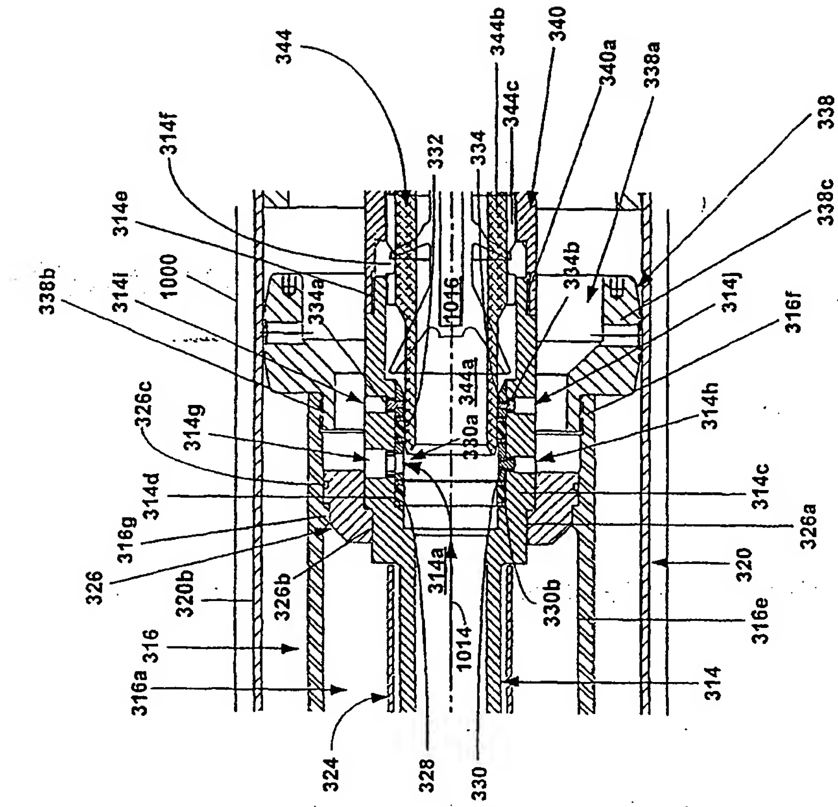
1004
1004

Fig. 34a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314c
316g
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1014
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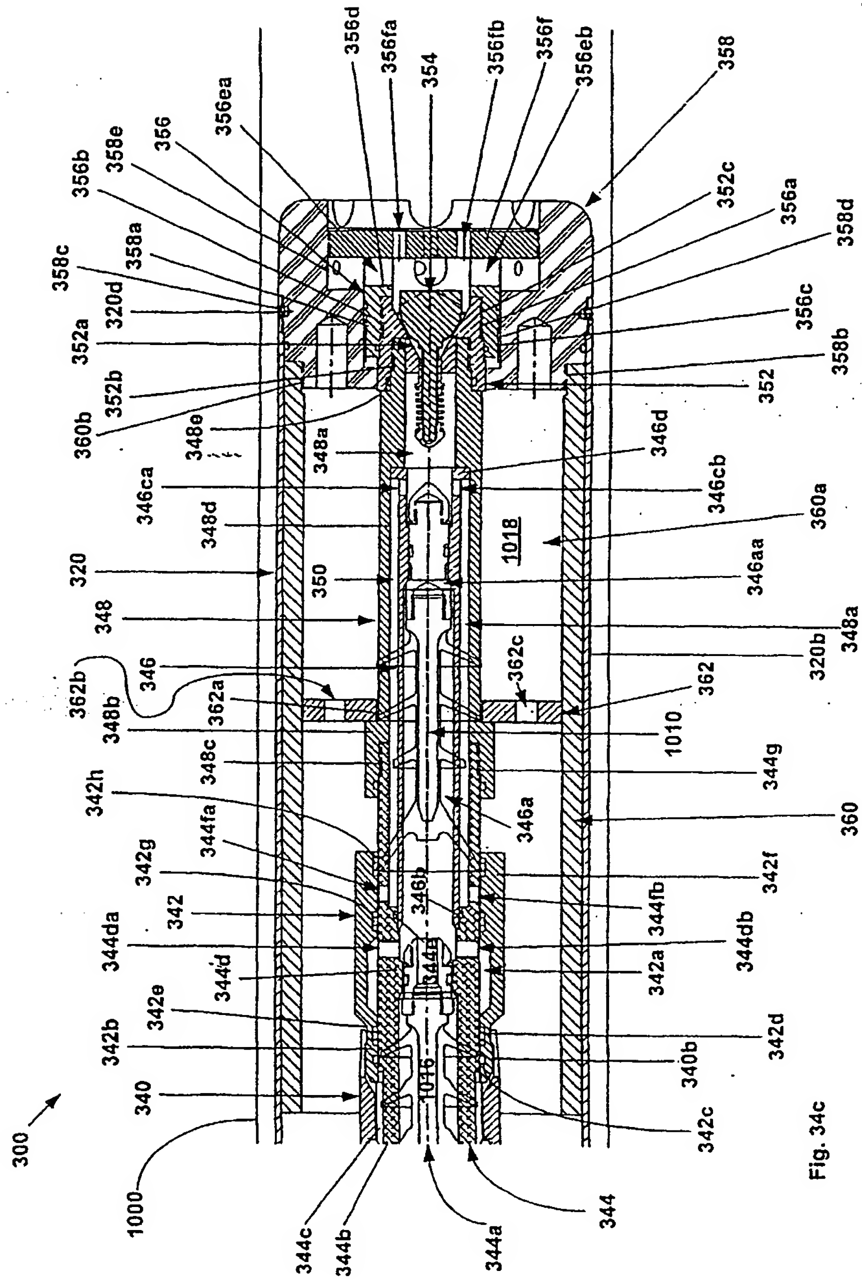
324
328
330

300

Fig. 34b



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342f
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344db
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342c
1016
320
344
344a
344b
344c

Fig. 34c

2399 120

FORMING A WELLBORE CASING

Background of the Invention

This invention relates generally to forming wellbore casings.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores.

Summary of the Invention

According to the present invention there is provided an apparatus for forming a wellbore casing in a borehole in a subterranean formation, comprising:

means for radially expanding and plastically deforming an expandable tubular member; and

means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole;

wherein the means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole, comprises a sliding sleeve valve.

According to another aspect of the present invention there is provided an apparatus for coupling an expandable tubular member to a preexisting structure, comprising:

means for radially expanding and plastically deforming the expandable tubular member within the preexisting structure; and

means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preexisting structure;
wherein the means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preexisting structure, comprises a sliding sleeve valve.

Brief Description of the Drawings

Figs. 1 and 1a-1c are cross sectional illustrations of a liner hanger assembly including a sliding sleeve valve assembly.

Figs. 2a-2b is a flow chart illustration of a method for forming a wellbore casing using the liner hanger assembly of Figs. 1 and 1a-1c.

Figs. 3a-3c are cross sectional illustrations of the placement of the liner hanger assembly of Figs. 1 and 1a-1c into a wellbore.

Figs. 4a-4c are cross sectional illustrations of the injection of fluidic materials into the liner hanger assembly of Figs. 3a-3c.

Figs. 5a-5c are cross sectional illustrations of the placement of a bottom plug into the liner hanger assembly of Figs. 4a-4c.

Figs. 6a-6c are cross sectional illustrations of the downward displacement of sliding sleeve of the liner hanger assembly of Figs. 5a-5c.

Figs. 7a-7c are cross sectional illustrations of the injection of a hardenable fluidic sealing material into the liner hanger assembly of Figs. 6a-6c that bypasses the plug.

Figs. 8a-8c are cross sectional illustrations of the placement of a top plug into the liner hanger assembly of Figs. 7a-7c.

Figs. 9a-9c are cross sectional illustrations of the upward displacement of sliding sleeve of the liner hanger assembly of Figs. 8a-8c.

Figs. 10a-10c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 9a-9c in order to radially expand and plastically deform the expansion cone launcher.

Figs. 11a-11b is a flow chart illustration of a method for forming a wellbore casing using the liner hanger assembly of Figs. 1 and 1a-1c.

Figs. 12a-12c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 5a-5c in order to at least partially radially expand and plastically deform the expansion cone launcher.

Figs. 13a-13c are cross sectional illustrations of the downward displacement of the sliding sleeve of the liner hanger assembly of Figs. 12a-12c.

Figs. 14a-14c are cross sectional illustrations of the injection of a hardenable fluidic sealing material through the liner hanger assembly of Figs. 13a-13c.

Figs. 15a-15c are cross sectional illustrations of the injection and placement of a top plug into the liner hanger assembly of Figs. 14a-14c.

Figs. 16a-16c are cross sectional illustrations of the upward displacement of the sliding sleeve of the liner hanger assembly of Figs. 15a-15c.

Figs. 17a-17c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 16a-16c in order to complete the radial expansion of the expansion cone launcher.

Figs. 18, 18a, 18b, and 18c are cross sectional illustrations of a liner hanger assembly including a sliding sleeve valve assembly.

Figs. 19a-19b is a flow chart illustration of a method for forming a wellbore casing using the liner hanger assembly of Figs. 18 and 18a-18c.

Figs. 20a-20c are cross sectional illustrations of the placement of the liner hanger assembly of Figs. 18 and 18a-18c into a wellbore.

Figs. 21a-21c are cross sectional illustrations of the injection of a fluidic materials into the liner hanger assembly of Figs. 20a-20c.

Figs. 22a-22c are cross sectional illustrations of the placement of a bottom plug into the liner hanger assembly of Figs. 21a-21c.

Figs. 23a-23c are cross sectional illustrations of the downward displacement of sliding sleeve of the liner hanger assembly of Figs. 22a-22c.

Figs. 24a-24c are cross sectional illustrations of the injection of a hardenable fluidic sealing material into the liner hanger assembly of Figs. 23a-23c that bypasses the bottom plug.

Figs. 25a-25c are cross sectional illustrations of the placement of a top plug into the liner hanger assembly of Figs. 24a-24c.

Figs. 26a-26c are cross sectional illustrations of the upward displacement of sliding sleeve of the liner hanger assembly of Figs. 25a-25c.

Figs. 27a-27c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 26a-26c in order to radially expand and plastically deform the expansion cone launcher.

Figs. 28a-28b is a flow chart illustration of a method for forming a wellbore casing using the liner hanger assembly of Figs. 18 and 18a-18c.

Figs. 29a-29c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 22a-22c in order to at least partially radially expand and plastically deform the expansion cone launcher.

Figs. 30a-30c are cross sectional illustrations of the downward displacement of the sliding sleeve of the liner hanger assembly of Figs. 29a-29c.

Figs. 31a-31c are cross sectional illustrations of the injection of a hardenable fluidic sealing material through the liner hanger assembly of Figs. 30a-30c.

Figs. 32a-32c are cross sectional illustrations of the injection and placement of a top plug into the liner hanger assembly of Figs. 31a-31c.

Figs. 33a-33c are cross sectional illustrations of the upward displacement of the sliding sleeve of the liner hanger assembly of Figs. 32a-32c.

Figs. 34a-34c are cross sectional illustrations of the injection of a pressurized fluidic material into the liner hanger assembly of Figs. 33a-33c in order to complete the radial expansion of the expansion cone launcher.

Detailed Description

A liner hanger assembly having a sliding sleeve bypass valve is provided. The liner hanger assembly provides a method and apparatus for forming or repairing a wellbore casing, a pipeline or a structural support.

Referring initially to Figs. 1, 1a, 1b, and 1c, a liner hanger assembly 10 includes a first tubular support member 12 defining an internal passage 12a that includes a threaded counterbore 12b at one end, and a threaded counterbore 12c at another end. A second tubular support member 14 defining an internal passage 14a includes a first threaded portion 14b at a first end that is coupled to the threaded counterbore 12c of the first tubular support member 12, a stepped flange 14c, a counterbore 14d, a threaded portion 14e, and internal splines 14f at another end. The stepped flange 14c of the second tubular support member 14 further defines radial passages 14g, 14h, 14i, and 14j. A third tubular support member 16 defining an internal passage 16a for receiving the second tubular support member 14 includes a first flange 16b, a second flange 16c, a first counterbore 16d, a second counterbore 16e having an internally threaded portion 16f, and an internal flange 16g. The second flange 16c further includes radial passages 16h and 16i.

An annular expansion cone 18 defining an internal passage 18a for receiving the second and third tubular support members, 14 and 16, includes a counterbore 18b at one end, and a counterbore 18c at another end for receiving the flange 16b of the second tubular support member 16. The annular expansion cone 18 further includes an end face 18d that mates with an end face 16j of the flange 16c of the second tubular support member 16, and an exterior surface 18e having a conical shape in order to facilitate the radial expansion of tubular members. A tubular expansion cone launcher 20 is movably coupled to the exterior surface 18e of the expansion cone 18 and includes a first portion 20a having a first wall thickness, a

second portion 20b having a second wall thickness, a threaded portion 20c at one end, and a threaded portion 20d at another end. The second portion 20b of the expansion cone launcher 20 mates with the conical outer surface 18e of the expansion cone 18. The second wall thickness is less than the first wall thickness in order to optimize the radial expansion of the expansion cone launcher 20 by the relative axial displacement of the expansion cone 18. One or more expandable tubulars are coupled to the threaded connection 20c of the expansion cone launcher 20. In this manner, the assembly 10 may be used to radially expand and plastically deform, for example, thousands of feet of expandable tubulars.

An annular spacer 22 defining an internal passage 22a for receiving the second tubular support member 14 is received within the counterbore 18b of the expansion cone 18, and is positioned between an end face 12d of the first tubular support member 12 and an end face of the counterbore 18b of the expansion cone 18. A fourth tubular support member 24 defining an internal passage 24a for receiving the second tubular support member 14 includes a flange 24b that is received within the counterbore 16d of the third tubular support member 16. A fifth tubular support member 26 defining an internal passage 26a for receiving the second tubular support member 14 includes an internal flange 26b for mating with the flange 14c of the second tubular support member and a flange 26c for mating with the internal flange 16g of the third tubular support member 16.

An annular sealing member 28, an annular sealing and support member 30, an annular sealing member 32, and an annular sealing and support member 34 are received within the counterbore 14d of the second tubular support member 14. The annular sealing and support member 30 further includes a radial opening 30a for supporting a rupture disc 36 within the radial opening 14g of the second tubular support member 14 and a sealing member 30b for sealing the radial opening 14h of the second tubular support member. The annular sealing and support member 34 further includes sealing members 34a and 34b for sealing the radial openings 14i and 14j, respectively, of the second tubular support member 14. The rupture disc 36 opens when the operating pressure within the radial opening 30b is about 6,894.745

to 34,473.724 KPa (1000 to 5000 psi). In this manner, the rupture disc 36 provides a pressure sensitive valve for controlling the flow of fluidic materials through the radial opening 30a. Alternatively, the assembly 10 includes a plurality of radial passages 30a, each with corresponding rupture discs 36.

A sixth tubular support member 38 defining an internal passage 38a for receiving the second tubular support member 14 includes a threaded portion 38b at one end that is coupled to the threaded portion 16f of the third tubular support member 16 and a flange 38c at another end that is movably coupled to the interior of the expansion cone launcher 20. An annular collet 40 includes a threaded portion 40a that is coupled to the threaded portion 14e of the second tubular support member 14, and a resilient coupling 40b at another end.

An annular sliding sleeve 42 defining an internal passage 42a includes an internal flange 42b, having sealing members 42c and 42d, and an external groove 42e for releasably engaging the coupling 40b of the collet 40 at one end, and an internal flange 42f, having sealing members 42g and 42h, at another end. During operation the coupling 40b of the collet 40 may engage the external groove 42e of the sliding sleeve 42 and thereby displace the sliding sleeve in the longitudinal direction. Since the coupling 40b of the collet 40 is resilient, the collet 40 may be disengaged or reengaged with the sliding sleeve 42. An annular valve member 44 defining an internal passage 44a, having a first throat 44aa and a second throat 44ab, includes a flange 44b at one end, having external splines 44c for engaging the internal splines 14f of the second tubular support member 14, a first set of radial passages, 44da and 44db, a second set of radial passages, 44ea and 44eb, and a threaded portion 44f at another end. The sliding sleeve 42 and the valve member 44 define an annular bypass passage 46 that, depending upon the position of the sliding sleeve 42, permits fluidic materials to flow from the passage 44 through the first radial passages, 44da and 44db, the bypass passage 46, and the second radial passages, 44ea and 44eb, back into the passage 44. In this manner, fluidic materials may bypass the portion of the passage 44 between the first and second radial passages, 44ea, 44eb, 44da, and 44db. Furthermore, the sliding sleeve 42 and the

valve member 44 together define a sliding sleeve valve for controllably permitting fluidic materials to bypass the intermediate portion of the passage 44a between the first and second passages, 44da, 44db, 44ea, and 44eb. During operation, the flange 44b limits movement of the sliding sleeve 42 in the longitudinal direction.

The collet 40 includes a set of couplings 40b such as, for example, fingers, that engage the external groove 42e of the sliding sleeve 42. During operation, the collet couplings 40b latch over and onto the external groove 42e of the sliding sleeve 42. A longitudinal force of at least about 4.448 to 57.827 kN (10,000 to 13,000 lbf) is required to pull the couplings 40b off of, and out of engagement with, the external groove 42e of the sliding sleeve 42. The application of a longitudinal force less than about 4.448 to 57.827 kN (10,000 to 13,000 lbf) indicates that the collet couplings 40b are latched onto the external shoulder of the sliding sleeve 42, and that the sliding sleeve 42 is in the up or the down position relative to the valve member 44. The collet 40 includes a conventional internal shoulder that transfers the weight of the first tubular support member 12 and expansion cone 18 onto the sliding sleeve 42. The collet 40 further includes a conventional set of internal lugs for engaging the splines 44c of the valve member 44.

An annular valve seat 48 defining a conical internal passage 48a for receiving a conventional float valve element 50 includes an annular recess 48b, having an internally threaded portion 48c for engaging the threaded portion 44f of the valve member 44, at one end, and an externally threaded portion 48d at another end. Alternatively, the float valve element 50 is omitted. An annular valve seat mounting element 52 defining an internal passage 52a for receiving the valve seat 48 and float valve 50 includes an internally threaded portion 52b for engaging the externally threaded portion 48d of the valve seat 48, an externally threaded portion 52c, an internal flange 52d, radial passages, 52ea and 52eb, and an end member 52f, having axial passages, 52fa and 52fb.

A shoe 54 defining an internal passage 54a for receiving the valve seat mounting element 52 includes a first annular recess 54b, having an externally threaded portion 54c, and a second annular recess 54d, having an externally threaded

portion 54e for engaging the threaded portion 20d of the expansion cone launcher 20, at one end, a first threaded counterbore 54f for engaging the threaded portion 52c of the of the mounting element, and a second counterbore 54g for mating with the end member 52f of the mounting element. The shoe 54 is fabricated from a ceramic and/or a composite material in order to facilitate the subsequent removal of the shoe by drilling. A seventh tubular support member 56 defining an internal passage 56a for receiving the sliding sleeve 42 and the valve member 44 is positioned within the expansion cone launcher 20 that includes an internally threaded portion 56b at one end for engaging the externally threaded portion 54c of the annular recess 54b of the shoe 54. During operation of the assembly, the end of the seventh tubular support member 56 limits the longitudinal movement of the expansion cone 18 in the direction of the shoe 54 by limiting the longitudinal movement of the sixth tubular support member 38. An annular centralizer 58 defining an internal passage 58a for movably supporting the sliding sleeve 42 is positioned within the seventh tubular support member 56 that includes axial passages 58b and 58c. The centralizer 58 maintains the sliding sleeve 42 and valve member 44 is a central position within the assembly 10.

Referring to Figs. 2a-2b, during operation, the assembly 10 may be used to form or repair a wellbore casing by implementing a method 200 in which, as illustrated in Figs. 3a-3c, the assembly 10 may initially be positioned within a wellbore 100 having a preexisting wellbore casing 102 by coupling a conventional tubular member 104 defining an internal passage 104a to the threaded portion 12b of the first tubular support member 12 in step 202. During placement of the assembly 10 within the wellbore 100, fluidic materials 106 within the wellbore 100 below the assembly 10 are conveyed through the assembly 10 and into the passage 104a by the fluid passages 52fa, 52fb, 54a, 48a, 44a, and 14a. In this manner, surge pressures that can be created during placement of the assembly 10 within the wellbore 100 are minimized. The float valve element 50 is pre-set in an auto-fill configuration to permit the fluidic materials 106 to pass through the conical passage 48a of the valve seat 48.

Referring to Figs. 4a-4c, in step 204, fluidic materials 108 may then be injected into and through the tubular member 104 and assembly 10 to thereby ensure that all of the fluid passages 104a, 14a, 44a, 48a, 54a, 52fa, and 52fb are functioning properly.

Referring to Figs. 5a-5c, in step 206, a bottom plug 110 may then be injected into the fluidic materials 108 and into the assembly 10 and then positioned in the throat passage 44ab of the valve member 44. In this manner, the region of the passage 44a upstream from the plug 110 may be fluidicly isolated from the region of the passage 44a downstream from the plug 110. The proper placement of the plug 110 may be indicated by a corresponding increase in the operating pressure of the fluidic material 108.

Referring to Figs. 6a-6c, in step 208, the sliding sleeve 42 may then be displaced relative to the valve member 44 by displacing the tubular member 104 by applying, for example, a downward force of approximately 5,000 lbf on the assembly 10. In this manner, the tubular member 104, the first tubular support member 12, the second tubular support member 14, the third tubular support member 16, the expansion cone 18, the annular spacer 22, the fourth tubular support member 24, the fifth tubular support member 26, the sixth tubular support member 38, the collet 40, and the sliding sleeve 42 are displaced in the longitudinal direction relative to the expansion cone launcher 20 and the valve member 44. In this manner, fluidic materials within the passage 44a upstream of the plug 110 may bypass the plug by passing through the first passages, 44da and 44db, through the annular passage 46, and through the second passages, 44ea and 44eb, into the region of the passage 44a downstream from the plug. Furthermore, in this manner, the rupture disc 36 is fluidicly isolated from the passages 14a and 44a.

Referring to Figs. 7a-7c, in step 210, a hardenable fluidic sealing material 112 may then be injected into the assembly 10 and conveyed through the passages 104a, 14a, 44a, 44da, 44db, 46, 44ea, 44eb, 48a, 54a, 52fa, and 52fb into the wellbore 100. In this manner, a hardenable fluidic sealing material such as, for example, cement, may be injected into the annular region between the expansion

cone launcher 20 and the wellbore 100 in order to subsequently form an annular body of cement around the radially expanded expansion cone launcher 20. Furthermore, in this manner, the radial passage 30a and the rupture disc 36 are not exposed to the hardenable fluidic sealing material 112.

Referring to Figs. 8a-8c, in step 212, upon the completion of the injection of the hardenable fluidic sealing material 112, a nonhardenable fluidic material 114 may be injected into the assembly 10, and a top plug 116 may then be injected into the assembly 10 along with the fluidic materials 114 and then positioned in the throat passage 44aa of the valve member 44. In this manner, the region of the passage 44a upstream from the first passages, 44da and 44db, may be fluidicly isolated from the first passages. The proper placement of the plug 116 may be indicated by a corresponding increase in the operating pressure of the fluidic material 114.

Referring to Fig. 9a-9c, in step 214, the sliding sleeve 42 may then be displaced relative to the valve member 44 by displacing the tubular member 104 by applying, for example, an upward force of approximately 57.827 kN (13,000 lbf) on the assembly 10. In this manner, the tubular member 104, the first tubular support member 12, the second tubular support member 14, the third tubular support member 16, the expansion cone 18, the annular spacer 22, the fourth tubular support member 24, the fifth tubular support member 26, the sixth tubular support member 38, the collet 40, and the sliding sleeve 42 are displaced in the longitudinal direction relative to the expansion cone launcher 20 and the valve member 44. In this manner, fluidic materials within the passage 44a upstream of the plug 110 may no longer bypass the plug by passing through the first passages, 44da and 44db, through the annular passage 46, and through the second passages, 44ea and 44eb, into the region of the passage 44a downstream from the plug. Furthermore, in this manner, the rupture disc 36 is no longer fluidicly isolated from the fluid passages 14a and 44a.

Referring to Figs. 10a-10c, in step 216, the fluidic material 114 may be injected into the assembly 10. The continued injection of the fluidic material 114

may increase the operating pressure within the passages 14a and 44a until the burst disc 36 is opened thereby permitting the pressurized fluidic material 114 to pass through the radial passage 30a and into an annular region 118 defined by the second tubular support member 14, the third tubular support member 16, the sixth tubular support member 38, the collet 40, the sliding sleeve 42, the shoe 54, and the seventh tubular support member 56. The pressurized fluidic material 114 within the annular region 118 directly applies a longitudinal force upon the fifth tubular support member 26 and the sixth tubular support member 38. The longitudinal force in turn is applied to the expansion cone 18. In this manner, the expansion cone 18 is displaced relative to the expansion cone launcher 20 thereby radially expanding and plastically deforming the expansion cone launcher.

Alternatively in the method 200, the injection and placement of the top plug 116 into the liner hanger assembly 10 in step 212 may be omitted.

Alternatively, in the method 200, in step 202, the assembly 10 is positioned at the bottom of the wellbore 100.

As illustrated in Figs. 11a-11b, during operation, the assembly 10 may be used to form or repair a wellbore casing by implementing a method 250 in which, as illustrated in Figs. 3a-3c, the assembly 10 may initially be positioned within a wellbore 100 having a preexisting wellbore casing 102 by coupling a conventional tubular member 104 defining an internal passage 104a to the threaded portion 12b of the first tubular support member 12 in step 252. During placement of the assembly 10 within the wellbore 100, fluidic materials 106 within the wellbore 100 below the assembly 10 are conveyed through the assembly 10 and into the passage 104a by the fluid passages 52fa, 52fb, 54a, 48a, 44a, and 14a. In this manner, surge pressures that can be created during placement of the assembly 10 within the wellbore 100 are minimized. The float valve element 50 is pre-set in an auto-fill configuration to permit the fluidic materials 106 to pass through the conical passage 48a of the valve seat 48.

Referring to Figs. 4a-4c, in step 254, fluidic materials 108 may then be injected into and through the tubular member 104 and assembly 10 to thereby ensure

that all of the fluid passages 104a, 14a, 44a, 48a, 54a, 52fa, and 52fb are functioning properly.

Referring to Figs. 5a-5c, in step 256, the bottom plug 110 may then be injected into the fluidic materials 108 and into the assembly 10 and then positioned in the throat passage 44ab of the valve member 44. In this manner, the region of the passage 44a upstream from the plug 110 may be fluidicly isolated from the region of the passage 44a downstream from the plug 110. The proper placement of the plug 110 may be indicated by a corresponding increase in the operating pressure of the fluidic material 108.

Referring to Figs. 12a-12c, in step 258, a fluidic material 114 may then be injected into the assembly to thereby increase the operating pressure within the passages 14a and 44a until the burst disc 36 is opened thereby permitting the pressurized fluidic material 114 to pass through the radial passage 30a and into an annular region 118 defined by the second tubular support member 14, the third tubular support member 16, the sixth tubular support member 38, the collet 40, the sliding sleeve 42, the shoe 54, and the seventh tubular support member 56. The pressurized fluidic material 114 within the annular region 118 directly applies a longitudinal force upon the fifth tubular support member 26 and the sixth tubular support member 38. The longitudinal force in turn is applied to the expansion cone 18. In this manner, the expansion cone 18 is displaced relative to the expansion cone launcher 20 thereby disengaging the collet 40 and the sliding sleeve 42 and radially expanding and plastically deforming the expansion cone launcher. The radial expansion process in step 408 is continued to a location below the overlap between the expansion cone launcher 20 and the preexisting wellbore casing 102.

Referring to Figs. 13a-13c, in step 260, the sliding sleeve 42 may then be displaced relative to the valve member 44 by (1) displacing the expansion cone 18 in a downward direction using the tubular member 104 and (2) applying, using the tubular member 104 a downward force of, for example, approximately 2.224 kN (5,000 lbf) on the assembly 10. In this manner, the coupling 40b of the collet 40 reengages the external groove 42e of the sliding sleeve 42. Furthermore, in this

manner, the tubular member 104, the first tubular support member 12, the second tubular support member 14, the third tubular support member 16, the expansion cone 18, the annular spacer 22, the fourth tubular support member 24, the fifth tubular support member 26, the sixth tubular support member 38, the collet 40, and the sliding sleeve 42 are displaced in the longitudinal direction relative to the expansion cone launcher 20 and the valve member 44. In this manner, fluidic materials within the passage 44a upstream of the plug 110 may bypass the plug by passing through the first passages, 44da and 44db, through the annular passage 46, and through the second passages, 44ea and 44eb, into the region of the passage 44a downstream from the plug. Furthermore, in this manner, the fluid passage 30a is fluidicly isolated from the passages 14a and 44a.

Referring to Figs. 14a-14c, in step 262, the hardenable fluidic sealing material 112 may then be injected into the assembly 10 and conveyed through the passages 104a, 14a, 44a, 44da, 44db, 46, 44ea, 44eb, 48a, 54a, 52fa, and 52fb into the wellbore 100. In this manner, a hardenable fluidic sealing material such as, for example, cement, may be injected into the annular region between the expansion cone launcher 20 and the wellbore 100 in order to subsequently form an annular body of cement around the radially expanded expansion cone launcher 20. Furthermore, in this manner, the radial passage 30a and the rupture disc 36 are not exposed to the hardenable fluidic sealing material 112.

Referring to Figs. 15a-15c, in step 264, upon the completion of the injection of the hardenable fluidic sealing material 112, the nonhardenable fluidic material 114 may be injected into the assembly 10, and the top plug 116 may then be injected into the assembly 10 along with the fluidic materials 114 and then positioned in the throat passage 44aa of the valve member 44. In this manner, the region of the passage 44a upstream from the first passages, 44da and 44db, may be fluidicly isolated from the first passages. The proper placement of the plug 116 may be indicated by a corresponding increase in the operating pressure of the fluidic material 114.

Referring to Figs. 16a-16c, in step 266, the sliding sleeve 42 may then be displaced relative to the valve member 44 by displacing the tubular member 104 by applying, for example, an upward force of approximately 57.827 kN (13,000 lbf) on the assembly 10. In this manner, the tubular member 104, the first tubular support member 12, the second tubular support member 14, the third tubular support member 16, the expansion cone 18, the annular spacer 22, the fourth tubular support member 24, the fifth tubular support member 26, the sixth tubular support member 38, the collet 40, and the sliding sleeve 42 are displaced in the longitudinal direction relative to the expansion cone launcher 20 and the valve member 44. In this manner, fluidic materials within the passage 44a upstream of the plug 110 may no longer bypass the plug by passing through the first passages, 44da and 44db, through the annular passage 46, and through the second passages, 44ea and 44eb, into the region of the passage 44a downstream from the plug. Furthermore, in this manner, the passage 30a is no longer fluidicly isolated from the fluid passages 14a and 44a.

Referring to Figs. 17a-17c, in step 268, the fluidic material 114 may be injected into the assembly 10. The continued injection of the fluidic material 114 may increase the operating pressure within the passages 14a, 30a, and 44a and the annular region 118. The pressurized fluidic material 114 within the annular region 118 directly applies a longitudinal force upon the fifth tubular support member 26 and the sixth tubular support member 38. The longitudinal force in turn is applied to the expansion cone 18. In this manner, the expansion cone 18 is displaced relative to the expansion cone launcher 20 thereby completing the radial expansion of the expansion cone launcher.

Alternatively, in the method 250, the injection and placement of the top plug 116 into the liner hanger assembly 10 in step 264 may omitted.

Alternatively, in the method 250, in step 252, the assembly 10 is positioned at the bottom of the wellbore 100.

Alternatively, in the method 250: (1) in step 252, the assembly 10 is positioned proximate a position below a preexisting section of the wellbore casing 102, and (2) in step 258, the expansion cone launcher 20, and any expandable

tubulars coupled to the threaded portion 20c of the expansion cone launcher, are radially expanded and plastically deformed until the shoe 54 of the assembly 10 is proximate the bottom of the wellbore 100. In this manner, the radial expansion process using the assembly 10 provides a telescoping of the radially expanded tubulars into the wellbore 100.

The assembly 10 may be operated to form a wellbore casing by including or excluding the float valve 50.

The float valve 50 may be operated in an auto-fill configuration in which tabs are positioned between the float valve 50 and the valve seat 48. In this manner, fluidic materials within the wellbore 100 may flow into the assembly 10 from below thereby decreasing surge pressures during placement of the assembly 10 within the wellbore 100. Furthermore, pumping fluidic materials through the assembly 10 at rate of about 1.2 to $2m^3$/min (6 to 8 bbl/min) will displace the tabs from the valve seat 48 and thereby allow the float valve 50 to close.

Prior to the placement of any of the plugs, 110 and 116, into the assembly 10, fluidic materials can be circulated through the assembly 10 and into the wellbore 100.

Once the bottom plug 110 has been positioned into the assembly 10, fluidic materials can only be circulated through the assembly 10 and into the wellbore 100 if the sliding sleeve 42 is in the down position.

Once the sliding sleeve 42 is positioned in the down position, the passage 30a and rupture disc 36 are fluidicly isolated from pressurized fluids within the assembly 10.

Once the top plug 116 has been positioned into the assembly 10, no fluidic materials can be circulated through the assembly 10 and into the wellbore 100.

The assembly 10 may be operated to form or repair a wellbore casing, a pipeline, or a structural support.

Referring to Figs. 18, 18a, 18b, and 18c, a liner hanger assembly 300 includes a first tubular support member 312 defining an internal passage 312a that includes a threaded counterbore 312b at one end, and a threaded counterbore 312c at

another end. A second tubular support member 314 defining an internal passage 314a includes a first threaded portion 314b at a first end that is coupled to the threaded counterbore 312c of the first tubular support member 312, a stepped flange 314c, a counterbore 314d, a threaded portion 314e, and internal splines 314f at another end. The stepped flange 314c of the second tubular support member 314 further defines radial passages 314g, 314h, 314i, and 314j.

A third tubular support member 316 defining an internal passage 316a for receiving the second tubular support member 314 includes a first flange 316b, a second flange 316c, a first counterbore 316d, a second counterbore 316e having an internally threaded portion 316f, and an internal flange 316g. The second flange 316c further includes radial passages 316h and 316i.

An annular expansion cone 318 defining an internal passage 318a for receiving the second and third tubular support members, 314 and 316, includes a counterbore 318b at one end, and a counterbore 318c at another end for receiving the flange 316b of the second tubular support member 316. The annular expansion cone 318 further includes an end face 318d that mates with an end face 316j of the flange 316c of the second tubular support member 316, and an exterior surface 318e having a conical shape in order to facilitate the radial expansion of tubular members. A tubular expansion cone launcher 320 is movably coupled to the exterior surface 318e of the expansion cone 318 and includes a first portion 320a having a first wall thickness, a second portion 320b having a second wall thickness, a threaded portion 320c at one end, and a threaded portion 320d at another end. The second portion 320b of the expansion cone launcher 320 mates with the conical outer surface 318e of the expansion cone 318. The second wall thickness of the second portion 320b is less than the first wall thickness of the first portion 320a in order to optimize the radial expansion of the expansion cone launcher 320 by the relative axial displacement of the expansion cone 318. One or more expandable tubulars are coupled to the threaded connection 320c of the expansion cone launcher 320. In this manner, the assembly 300 may be used to radially expand and plastically deform, for example, thousands of feet of expandable tubulars.

An annular spacer 322 defining an internal passage 322a for receiving the second tubular support member 314 is received within the counterbore 318b of the expansion cone 318, and is positioned between an end face 312d of the first tubular support member 312 and an end face of the counterbore 318b of the expansion cone 318. A fourth tubular support member 324 defining an internal passage 324a for receiving the second tubular support member 314 includes a flange 324b that is received within the counterbore 316d of the third tubular support member 316. A fifth tubular support member 326 defining an internal passage 326a for receiving the second tubular support member 314 includes an internal flange 326b for mating with the flange 314c of the second tubular support member and a flange 326c for mating with the internal flange 316g of the third tubular support member 316.

An annular sealing member 328, an annular sealing and support member 330, an annular sealing member 332, and an annular sealing and support member 334 are received within the counterbore 314d of the second tubular support member 314. The annular sealing and support member 330 further includes a radial opening 330a for supporting a rupture disc 336 within the radial opening 314g of the second tubular support member 314 and a sealing member 330b for sealing the radial opening 314h of the second tubular support member. The annular sealing and support member 334 further includes sealing members 334a and 334b for sealing the radial openings 314i and 314j, respectively, of the second tubular support member 314. The rupture disc 336 opens when the operating pressure within the radial opening 330b is about 6,894.745 to 34,473.724 KPa (1000 to 5000 psi). In this manner, the rupture disc 336 provides a pressure sensitive valve for controlling the flow of fluidic materials through the radial opening 330a. Alternatively, the assembly 300 includes a plurality of radial passages 330a, each with corresponding rupture discs 336.

A sixth tubular support member 338 defining an internal passage 338a for receiving the second tubular support member 314 includes a threaded portion 338b at one end that is coupled to the threaded portion 316f of the third tubular support member 316 and a flange 338c at another end that is movably coupled to the interior

of the expansion cone launcher 320. An annular collet 340 includes a threaded portion 340a that is coupled to the threaded portion 314e of the second tubular support member 314, and a resilient coupling 340b at another end.

An annular sliding sleeve 342 defining an internal passage 342a includes an internal flange 342b, having sealing members 342c and 342d, and an external groove 342e for releasably engaging the coupling 340b of the collet 340 at one end, and an internal flange 342f, having sealing members 342g and 342h, at another end. During operation, the coupling 340b of the collet 340 may engage the external groove 342e of the sliding sleeve 342 and thereby displace the sliding sleeve in the longitudinal direction. Since the coupling 340b of the collet 340 is resilient, the collet 340 may be disengaged or reengaged with the sliding sleeve 342. An annular valve member 344 defining an internal passage 344a, having a throat 344aa, includes a flange 344b at one end, having external splines 344c for engaging the internal splines 314f of the second tubular support member 314, an interior flange 344d having a first set of radial passages, 344da and 344db, and a counterbore 344e, a second set of radial passages, 344fa and 344fb, and a threaded portion 344g at another end.

An annular valve member 346 defining an internal passage 346a, having a throat 346aa, includes an end portion 346b that is received in the counterbore 344e of the annular valve member 344, a set of radial openings, 346ca and 346cb, and a flange 346d at another end. An annular valve member 348 defining an internal passage 348a for receiving the annular valve members 344 and 346 includes a flange 348b having a threaded counterbore 348c at one end for engaging the threaded portion 344g of the annular valve member, a counterbore 348d for mating with the flange 346d of the annular valve member, and a threaded annular recess 348e at another end.

The annular valve members 344, 346, and 348 define an annular passage 350 that fluidicly couples the radial passages 344fa, 344fb, 346ca, and 346cb. Furthermore, depending upon the position of the sliding sleeve 342, the fluid passages, 344da and 344db, may be fluidicly coupled to the passages 344fa, 344fb,

346ca, 346cb, and 350. In this manner, fluidic materials may bypass the portion of the passage 346a between the passages 344da, 344db, 346ca, and 346cb.

Furthermore, the sliding sleeve 342 and the valve members 344, 346, and 348 together define a sliding sleeve valve for controllably permitting fluidic materials to bypass the intermediate portion of the passage 346a between the passages, 344da, 344db, 346ca, and 346cb. During operation of the sliding sleeve valve, the flange 348b limits movement of the sliding sleeve 342 in the longitudinal direction.

The collet 340 includes a set of couplings 340b that engage the external groove 342e of the sliding sleeve 342. During operation, the collet couplings 340b latch over and onto the external groove 342e of the sliding sleeve 342. A longitudinal force of at least about 4.448 to 57.827 kN (10,000 to 13,000 lbf) is required to pull the couplings 340b off of, and out of engagement with, the external groove 342e of the sliding sleeve 342. The application of a longitudinal force less than about 4.448 to 57.827 kN (10,000 to 13,000 lbf) indicates that the collet couplings 340b are latched onto the external shoulder of the sliding sleeve 342, and that the sliding sleeve 342 is in the up or the down position relative to the valve member 344. The collet 340 includes a conventional internal shoulder that transfers the weight of the first tubular support member 312 and expansion cone 318 onto the sliding sleeve 342. The collet 340 further includes a conventional set of internal lugs for engaging the splines 344c of the valve member 344.

An annular valve seat 352 defining a conical internal passage 352a for receiving a conventional float valve element 354 includes a threaded annular recess 352b for engaging the threaded portion 348e of the valve member 348, at one end, and an externally threaded portion 352c at another end. Alternatively, the float valve element 354 is omitted. An annular valve seat mounting element 356 defining an internal passage 356a for receiving the valve seat 352 and float valve 354 includes an internally threaded portion 356b for engaging the externally threaded portion 352c of the valve seat 352, an externally threaded portion 356c, an internal flange 356d, radial passages, 356ea and 356eb, and an end member 356f, having axial passages, 356fa and 356fb.

A shoe 358 defining an internal passage 358a for receiving the valve seat mounting element 356 includes a first threaded annular recess 358b, and a second threaded annular recess 358c for engaging the threaded portion 320d of the expansion cone launcher 320, at one end, a first threaded counterbore 358d for engaging the threaded portion 356c of the of the valve seat mounting element, and a second counterbore 358e for mating with the end member 356f of the mounting element. The shoe 358 is fabricated from a ceramic and/or a composite material in order to facilitate the subsequent removal of the shoe by drilling.

A seventh tubular support member 360 defining an internal passage 360a for receiving the sliding sleeve 342 and the valve members 344, 346, and 348 is positioned within the expansion cone launcher 320 that includes an internally threaded portion 360b at one end for engaging the externally threaded portion of the annular recess 358b of the shoe 358. During operation of the assembly, the end of the seventh tubular support member 360 limits the longitudinal movement of the expansion cone 318 in the direction of the shoe 358 by limiting the longitudinal movement of the sixth tubular support member 338. An annular centralizer 362 defining an internal passage 362 for supporting the valve member 348 is positioned within the seventh tubular support member 360 that includes axial passages 362b and 362c.

Referring to Figs. 19a-19b, during operation, the assembly 300 may be used to form or repair a wellbore casing by implementing a method 400 in which, as illustrated in Figs. 20a-20c, the assembly 300 may initially be positioned within a wellbore 1000 having a preexisting wellbore casing 1002 by coupling a conventional tubular member 1004 defining an internal passage 1004a to the threaded portion 312b of the first tubular support member 312 in step 402. During placement of the assembly 300 within the wellbore 1000, fluidic materials 1006 within the wellbore 1000 below the assembly 300 are conveyed through the assembly 300 and into the passage 1004a by the fluid passages 356fa, 356fb, 352a, 348a, 346a, 344a, and 314a. In this manner, surge pressures that can be created during placement of the assembly 300 within the wellbore 1000 are minimized. The

float valve element 354 is pre-set in an auto-fill configuration to permit the fluidic materials 1006 to pass through the conical passage 352a of the valve seat 352.

Referring to Figs. 21a-21c, in step 404, fluidic materials 1008 may then be injected into and through the tubular member 1004 and assembly 300 to thereby ensure that all of the fluid passages 1004a, 314a, 344a, 346a, 348a, 352a, 356fa, and 356fb are functioning properly.

Referring to Figs. 22a-22c, in step 406, a bottom plug 1010 may then be injected into the fluidic materials 1008 and into the assembly 300 and then positioned in the throat passage 346aa of the valve member 346. In this manner, the region of the passage 346a upstream from the plug 1010 may be fluidicly isolated from the region of the passage 346a downstream from the plug 1010. The proper placement of the plug 1010 may be indicated by a corresponding increase in the operating pressure of the fluidic material 1008.

Referring to Figs. 23a-23c, in step 408, the sliding sleeve 342 may then be displaced relative to the valve member 344 by displacing the tubular member 1004 by applying, for example, a downward force of approximately 2.224 kN (5,000 lbf) on the assembly 300. In this manner, the tubular member 1004, the first tubular support member 312, the second tubular support member 314, the third tubular support member 316, the expansion cone 318, the annular spacer 322, the fourth tubular support member 324, the fifth tubular support member 326, the sixth tubular support member 338, the collet 340, and the sliding sleeve 342 are displaced in the longitudinal direction relative to the expansion cone launcher 320 and the valve member 344. In this manner, fluidic materials within the passage 344a upstream of the plug 1010 may bypass the plug by passing through the first passages, 344da and 344db, through the annular passage 342a, through the second passages, 344fa and 344fb, through the annular passage 350, through the passages, 346ca and 346cb, into the region of the passage 348a downstream from the plug. Furthermore, in this manner, the rupture disc 336 is fluidicly isolated from the passages 314a and 344a.

Referring to Figs. 24a-24c, in step 410, a hardenable fluidic sealing material 1012 may then be injected into the assembly 300 and conveyed through the passages

1004a, 314a, 344a, 344da, 344db, 342a, 344fa, 344fb, 350, 346ca, 346cb, 348a, 352a, 356fa, and 356fb into the wellbore 1000. In this manner, a hardenable fluidic sealing material such as, for example, cement, may be injected into the annular region between the expansion cone launcher 320 and the wellbore 1000 in order to subsequently form an annular body of cement around the radially expanded expansion cone launcher 320. Furthermore, in this manner, the radial passage 330a and the rupture disc 336 are not exposed to the hardenable fluidic sealing material 1012.

Referring to Figs. 25a-25c, in step 412, upon the completion of the injection of the hardenable fluidic sealing material 1012, a nonhardenable fluidic material 1014 may be injected into the assembly 300, and a top plug 1016 may then be injected into the assembly 300 along with the fluidic materials 1014 and then positioned in the throat passage 344aa of the valve member 344. In this manner, the region of the passage 344a upstream from the top plug 1016 may be fluidicly isolated from region downstream from the top plug. The proper placement of the plug 1016 may be indicated by a corresponding increase in the operating pressure of the fluidic material 1014.

Referring to Fig. 26a-26c, in step 414, the sliding sleeve 42 may then be displaced relative to the valve member 344 by displacing the tubular member 1004 by applying, for example, an upward force of approximately 57.827 kN (13,000 lbf) on the assembly 300. In this manner, the tubular member 1004, the first tubular support member 312, the second tubular support member 314, the third tubular support member 316, the expansion cone 318, the annular spacer 322, the fourth tubular support member 324, the fifth tubular support member 326, the sixth tubular support member 338, the collet 340, and the sliding sleeve 342 are displaced in the longitudinal direction relative to the expansion cone launcher 320 and the valve member 344. In this manner, fluidic materials within the passage 344a upstream of the bottom plug 1010 may no longer bypass the bottom plug by passing through the first passages, 344da and 344db, through the annular passage 342a, through the second passages, 344fa and 344fb, through the annular passage 350, and through the

passages, 346ca and 346cb, into region of the passage 348a downstream from the bottom plug. Furthermore, in this manner, the rupture disc 336 is no longer fluidicly isolated from the fluid passages 314a and 344a.

Referring to Figs. 27a-27c, in step 416, the fluidic material 1014 may be injected into the assembly 300. The continued injection of the fluidic material 1014 may increase the operating pressure within the passages 314a and 344a until the burst disc 336 is opened thereby permitting the pressurized fluidic material 1014 to pass through the radial passage 330a and into an annular region 1018 defined by the second tubular support member 314, the third tubular support member 316, the sixth tubular support member 338, the collet 340, the sliding sleeve 342, the valve members, 344 and 348, the shoe 358, and the seventh tubular support member 360. The pressurized fluidic material 1014 within the annular region 1018 directly applies a longitudinal force upon the fifth tubular support member 326 and the sixth tubular support member 338. The longitudinal force in turn is applied to the expansion cone 318. In this manner, the expansion cone 318 is displaced relative to the expansion cone launcher 320 thereby radially expanding and plastically deforming the expansion cone launcher.

Alternatively, in the method 400, the injection and placement of the top plug 1016 into the liner hanger assembly 300 in step 412 may omitted.

Alternatively, in the method 400, in step 402, the assembly 300 is positioned at the bottom of the wellbore 1000.

As illustrated in Figs. 28a-28b, during operation, the assembly 300 may be used to form or repair a wellbore casing by implementing a method 450 in which, as illustrated in Figs. 20a-20c, the assembly 300 may initially be positioned within a wellbore 1000 having a preexisting wellbore casing 1002 by coupling a conventional tubular member 1004 defining an internal passage 1004a to the threaded portion 312b of the first tubular support member 312 in step 452. During placement of the assembly 300 within the wellbore 1000, fluidic materials 1006 within the wellbore 1000 below the assembly 300 are conveyed through the assembly 300 and into the passage 1004a by the fluid passages 356fa, 356fb, 352a,

348a, 346a, 344a, and 314a. In this manner, surge pressures that can be created during placement of the assembly 300 within the wellbore 1000 are minimized. The float valve element 354 is pre-set in an auto-fill configuration to permit the fluidic materials 1006 to pass through the conical passage 352a of the valve seat 352.

Referring to Figs. 21a-21c, in step 454, in step 454, fluidic materials 1008 may then be injected into and through the tubular member 1004 and assembly 300 to thereby ensure that all of the fluid passages 1004a, 314a, 344a, 346a, 348a, 352a, 356fa, and 356fb are functioning properly.

Referring to Figs. 22a-22c, in step 456, the bottom plug 1010 may then be injected into the fluidic materials 1008 and into the assembly 300 and then positioned in the throat passage 346aa of the valve member 346. In this manner, the region of the passage 346a upstream from the plug 1010 may be fluidicly isolated from the region of the passage 346a downstream from the plug 1010. The proper placement of the plug 1010 may be indicated by a corresponding increase in the operating pressure of the fluidic material 1008.

Referring to Figs. 29a-29c, in step 458, the fluidic material 1014 may then be injected into the assembly 300 to thereby increase the operating pressure within the passages 314a and 344a until the burst disc 336 is opened thereby permitting the pressurized fluidic material 1014 to pass through the radial passage 330a and into an annular region 1018 defined by the defined by the second tubular support member 314, the third tubular support member 316, the sixth tubular support member 338, the collet 340, the sliding sleeve 342, the valve members, 344 and 348, the shoe 358, and the seventh tubular support member 360. The pressurized fluidic material 1014 within the annular region 1018 directly applies a longitudinal force upon the fifth tubular support member 326 and the sixth tubular support member 338. The longitudinal force in turn is applied to the expansion cone 318. In this manner, the expansion cone 318 is displaced relative to the expansion cone launcher 320 thereby disengaging the collet 340 and the sliding sleeve 342 and radially expanding and plastically deforming the expansion cone launcher. The radial expansion process in

step 458 is continued to a location below the overlap between the expansion cone launcher 320 and the preexisting wellbore casing 1002.

Referring to Figs. 30a-30c, in step 460, the sliding sleeve 342 may then be displaced relative to the valve member 344 by (1) displacing the expansion cone 318 in a downward direction using the tubular member 1004 and (2) applying, using the tubular member 1004 a downward force of, for example, approximately 2.224 kN (5,000 lbf) on the assembly 300. In this manner, the coupling 340b of the collet 340 reengages the external groove 342e of the sliding sleeve 342. Furthermore, in this manner, the tubular member 1004, the first tubular support member 312, the second tubular support member 314, the third tubular support member 316, the expansion cone 318, the annular spacer 322, the fourth tubular support member 324, the fifth tubular support member 326, the sixth tubular support member 338, the collet 340, and the sliding sleeve 342 are displaced in the longitudinal direction relative to the expansion cone launcher 320 and the valve member 344. In this manner, fluidic materials within the passage 344a upstream of the bottom plug 1010 may bypass the plug by passing through the passages, 344da and 344db, the annular passage 342a, the passages, 344fa and 344fb, the annular passage 350, and the passages, 346ca and 346cb, into the passage 348a downstream from the plug. Furthermore, in this manner, the fluid passage 330a is fluidicly isolated from the passages 314a and 344a.

Referring to Figs. 31a-31c, in step 462, the hardenable fluidic sealing material 1012 may then be injected into the assembly 300 and conveyed through the passages 1004a, 314a, 344a, 344da, 344db, 342, 344fa, 344fb, 350, 346ca, 346cb, 348a, 352b, 356fa, and 356fb into the wellbore 1000. In this manner, a hardenable fluidic sealing material such as, for example, cement, may be injected into the annular region between the expansion cone launcher 320 and the wellbore 1000 in order to subsequently form an annular body of cement around the radially expanded expansion cone launcher 320. Furthermore, in this manner, the radial passage 330a and the rupture disc 336 are not exposed to the hardenable fluidic sealing material 1012.

Referring to Figs. 32a-32c, in step 464, upon the completion of the injection of the hardenable fluidic sealing material 1012, the nonhardenable fluidic material 1014 may be injected into the assembly 300, and the top plug 1016 may then be injected into the assembly 300 along with the fluidic materials 1014 and then positioned in the throat passage 344aa of the valve member 344. In this manner, the region of the passage 344a upstream from the top plug 1016 may be fluidicly isolated from the region within the passage downstream from the top plug. The proper placement of the plug 1016 may be indicated by a corresponding increase in the operating pressure of the fluidic material 1014.

Referring to Figs. 33a-33c, in step 466, the sliding sleeve 342 may then be displaced relative to the valve member 344 by displacing the tubular member 1004 by applying, for example, an upward force of approximately 57.827 kN (13,000 lbf) on the assembly 300. In this manner, the tubular member 1004, the first tubular support member 312, the second tubular support member 314, the third tubular support member 316, the expansion cone 318, the annular spacer 322, the fourth tubular support member 324, the fifth tubular support member 326, the sixth tubular support member 338, the collet 340, and the sliding sleeve 342 are displaced in the longitudinal direction relative to the expansion cone launcher 320 and the valve member 344. In this manner, fluidic materials within the passage 344a upstream of the bottom plug 110 may no longer bypass the plug by passing through the passages, 344da and 344db, the annular passage 342a, the passages, 344fa and 344fb, the annular passage 350, and the passages, 346ca and 346cb, into the passage 348a downstream from the plug. Furthermore, in this manner, the passage 330a is no longer fluidicly isolated from the fluid passages 314a and 344a.

Referring to Figs. 34a-34c, in step 468, the fluidic material 1014 may be injected into the assembly 300. The continued injection of the fluidic material 1014 may increase the operating pressure within the passages 314a, 330a, and 344a and the annular region 1018. The pressurized fluidic material 1014 within the annular region 1018 directly applies a longitudinal force upon the fifth tubular support member 326 and the sixth tubular support member 338. The longitudinal force in

turn is applied to the expansion cone 318. In this manner, the expansion cone 318 is displaced relative to the expansion cone launcher 320 thereby completing the radial expansion of the expansion cone launcher.

Alternatively, in the method 450, the injection and placement of the top plug 1016 into the liner hanger assembly 300 in step 464 may omitted.

Alternatively, in the method 450, in step 452, the assembly 300 is positioned at the bottom of the wellbore 1000.

Alternatively, in the method 450: (1) in step 452, the assembly 300 is positioned proximate a position below a preexisting section of the wellbore casing 1002, and (2) in step 458, the expansion cone launcher 320, and any expandable tubulars coupled to the threaded portion 320c of the expansion cone launcher, are radially expanded and plastically deformed until the shoe 358 of the assembly 300 is proximate the bottom of the wellbore 1000. In this manner, the radial expansion process using the assembly 300 provides a telescoping of the radially expanded tubulars into the wellbore 1000.

The assembly 300 may be operated to form a wellbore casing by including or excluding the float valve 354.

The float valve 354 may be operated in an auto-fill configuration in which tabs are positioned between the float valve 354 and the valve seat 352. In this manner, fluidic materials within the wellbore 1000 may flow into the assembly 300 from below thereby decreasing surge pressures during placement of the assembly 300 within the wellbore 1000. Furthermore, pumping fluidic materials through the assembly 300 at rate of about 1.2 to 2m^3/min (6 to 8 bbl/min) will displace the tabs from the valve seat 352 and thereby allow the float valve 354 to close.

Prior to the placement of any of the plugs, 1010 and 1016, into the assembly 300, fluidic materials can be circulated through the assembly 300 and into the wellbore 1000.

Once the bottom plug 1010 has been positioned into the assembly 300, fluidic materials can only be circulated through the assembly 300 and into the wellbore 1000 if the sliding sleeve 342 is in the down position.

Once the sliding sleeve 342 is positioned in the down position, the passage 330a and rupture disc 336 are fluidicly isolated from pressurized fluids within the assembly 300.

Once the top plug 1016 has been positioned into the assembly 300, no fluidic materials can be circulated through the assembly 300 and into the wellbore 1000.

The assembly 300 may be operated to form or repair a wellbore casing, a pipeline, or a structural support.

Although this detailed description has shown and described illustrative embodiments of the invention, this description contemplates a wide range of modifications, changes, and substitutions within the scope of the claims. In some instances, one may employ some features without a corresponding use of the other features and accordingly, it is appropriate that readers should construe the appended claims broadly .

CLAIMS

1. An apparatus for forming a wellbore casing in a borehole in a subterranean formation, comprising:

means for radially expanding and plastically deforming an expandable tubular member; and

means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole;

wherein the means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole, comprises a sliding sleeve valve.

2. An apparatus for coupling an expandable tubular member to a preexisting structure, comprising:

means for radially expanding and plastically deforming the expandable tubular member within the preexisting structure; and

means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preeexisting structure;

wherein the means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preexisting structure, comprises a sliding sleeve valve.